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THE MANUAL

OF THE

RAILWAY SIGNAL ASSOCIATION

A compilation of the findings, conclusions, standards and specifications
of the
RAILWAY SIGNAL ASSOCIATION
Made for the Board of Direction by a Committee consisting of
H. S. Balliet, C. C. Rosenberg, W. J. Eck, Chairman

SECOND EDITION
Revised 1913

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IMPORTANT.

Railway Signal Association.

REVISION OF MANUAL.

Index showing the location in which the various subjects enclosed herewith are to be placed, as well as transposition of existing subjects now in the Manual. When complete to appear in the order shown below.

NOTE.—Definitions for terms used: **Substitute**, replacing existing matter. **Insert**, entire new matter. **No change**, existing matter in old edition to remain. The sheets marked **substitue** and **insert** are collated in the order specified below, and if care is taken can be readily inserted in first edition. Do not mistake sheets for pages.

- Title Page. **One sheet, substitute.**
- Contents. **Two sheets, insert.**
- Subdivision Sheet A. **One sheet, substitute.**
- Automatic Block Signals, A.C. using D.C. for Propulsion.
  - Index. **Two sheets, no change.**
  - Specifications:
    - Pages 1 to 14, inclusive. **Seven sheets, no change.**
    - Pages 15 to 32, inclusive. **Nine sheets, substitute.**
- Automatic Block Signals, A.C. Steam Railways, etc.
  - Index. **Two sheets, insert.**
  - Specifications. **Seventeen sheets, insert.**
- Automatic Block Signals, Operated by Direct Current.
  - Index. **Two sheets, no change.**
  - Specifications:
    - Pages 1 to 12, inclusive. **Six sheets, no change.**
    - Pages 13 to 16, inclusive. **Two sheets, substitute.**
    - Pages 17 to 24, inclusive. **Four sheets, no change.**
    - Pages 25 to 30, inclusive. **Three sheets, substitute.**
- Automatic Stops and Cab Signals. **One sheet, no change.**
- Subdivision Sheet B. **One sheet, substitute.**
- Battery:
  - Specifications for Caustic Soda Primary. **One sheet, no change.**
  - Drawing 1053, Signal Cell. **One Sheet, substitute.**
  - Drawing 1087, Zincs. **One sheet, no change.**
  - Drawing 1088, Coppers. **One sheet, no change.**
  - Electrolyte, New, Tests for. **One sheet, no change.**
  - Storage, Lead Type, Description of. **One sheet, no change.**
  - Storage, Lead Type, Instructions. **One sheet, no change.**
  - Storage, At Interlockings, Instructions. **Two sheets, no change.**
  - Storage, Block Signals, Operation. **Two sheets, no change.**
  - Storage, Directions for Installation. **One sheet, no change.**
  - Storage, Portable, Instructions. **Two sheets, no change.**
  - Storage, Portable, Specifications, including three cuts. **Six sheets, no change.**

Storage, Stationary, Specifications. **Two sheets, insert.**
Drawing 1174, Charging Panel. **One sheet, insert.**
Drawing 1224, Lead Type Storage. **One sheet, insert.**
Storage, Stationary, Directions. **Two sheets, no change.**
Subdivision Sheet C. **One sheet, substitute.**

NOTE.—Cables have been taken out of the Wire specifications and are placed under separate heading.

Cables:
Aerial Braided, 660 V., Specifications. **Four sheets, substitute.**
Armored Submarine, 660 V., Specifications. **Five sheets, substitute.**
Armored Submarine, 2200 V., Specifications. **Five sheets, insert.**
Lead Covered, 660 V., Specifications. **Four sheets, substitute.**
Lead Covered, 2200 V., Specifications. **Four sheets, substitute.**
Underground Braided, 660 V., Specifications. **Four sheets, substitute.**
Channel Pins, Specifications. **Two sheets, substitute.**

NOTE.—Circuit plans are later to be placed in a volume of useful information.

Concrete, Specifications. **Two sheets, no change.**
Conduit, Fibre, Specifications. **One sheet, insert.**
Conduit, Vitrified Clay, Specifications. **Two sheets, insert.**
Copper Sulphate, Specifications. **One sheet, no change.**
Crossarms, Wood, Specifications. **Two sheets, insert.**
Crossarm Braces, Specifications. **One sheet, insert.**
Crossarm Pins, Specifications. **Two sheets, insert.**
Crossarm Through Bolts, Specifications. **One sheet, insert.**
Subdivision Sheet D. **One sheet, substitute.**
Definitions for Technical Terms. **Two sheets, no change.**
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1036, 1034, **no change.**
1229, 1228, 1227, 1230, **insert.**
1082, 1065, 1090, 1091, 1092, **no change.**
1056, superseding 1055, **insert.**
1049, **no change.**
1032, 1179, 1190, 1178, 1191, 1180, 1181, **insert.**
1071, 1072, 1073, 1083, 1059, 1013, 1014, **no change.**
1102, **substitute.**
1204, 1205, **insert.**
1011, 1012, 1004, 1003, 1007, 1006, 1005, **no change.**
1199, 1198, **insert.**
1008, 1009, **no change.**
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1219, 1220, 1089, 1206, 1069, 1098, 1097, **insert.**
1104, **substitute.**
1203, 1217, **insert.**
1106, **substitute.**
1052, **no change.**
1107, **substitute.**
1080, 1109, **no change.**

1200, **insert.**
1173, **insert.**
1094, 1017, 1020, 1021, 1019, 1022, 1016, 1018, 1026, 1029, 1027, 1101, 1100, **no change.**
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1086, **substitute.**
1010, 1033, **no change.**
1167, 1165, 1166, 1195, 1196, **insert.**
1015, **no change.**
1185, **insert.**
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1182, 1060, 1061, 1062, 1201, **insert.**
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1040, 1041, **substitute.**
1233, 1194, 1064, **insert.**
1042, **no change.**
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*NOTE.—Where additions or revisions have been made in existing sections or paragraphs, such changes are designated at the end of section or paragraph by the insertion of the year in which such change was made. Where the entire subject has been revised or new matter inserted, the date will appear underneath the title.

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Automatic
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REQUISITES.

ADJUNCTS.

430. *Lamps.*—Continued.

(d) .... (..) extra incandescent lamps shall be furnished.

431. *Lamp boxes.*

Lamp boxes shall be in accordance with .... drawing ....

435. *Signal locations.*

(a) Signal masts shall be on the right of the track governed and adjacent thereto where practicable.

(b) Signal arms on tangent shall be at right angles to track governed when sufficient approach is on tangent. On curves signal arms shall be at right angles to imaginary line drawn from the signal to the point where the best view can be obtained by the engineman, as decided by the Purchaser.

(c) Signals placed between tracks on tangent shall be set so that the center of mast shall be midway between tracks. Signals placed between tracks on curves shall be set off the center line between tracks and towards the center of the curve two and one-half (2 1/2) inches for each one (1) inch superelevation.

(d) Before any signals are erected, the Purchaser shall, in the presence of the Contractor's foreman (or other representative), locate each signal.

(e) Outside of tracks, ground masts shall be placed .... (..) feet and bracket posts .... (..) feet from nearest rail.

(f) Bridge masts shall be located on .... chord of bridge.

(g) Base of high signals shall be .... (..) inches below base of rail.

440. *Electric motor type.*

(a) Signals shall be of the electric motor type, low voltage holding device and low voltage alternating current $\left\{\begin{matrix}\text{commutating}\\ \text{induction}\end{matrix}\right\}$ motor, operating mechanism located at ....

(b) Motor shall operate the semaphore arm from zero through an arc of [ninety (90)] degrees in [ten (10)] seconds at [one hundred and ten (110)] volts, [single] phase, [twenty-five (25)] cycles, consuming not more than $\left\{\begin{matrix}\text{commutating} & 125\\ \text{induction} & 250\end{matrix}\right\}$ volt-amperes with a power-factor

440. *Electric motor type.*—Continued.

of [seventy (70)] per cent. Starting and operating current at any point of the arc shall not exceed $\left\{\begin{array}{ll} \text{commutating} & 275 \\ \text{induction} & 550 \end{array}\right\}$ volt-amperes. 1912.

(c) Motor shall operate the semaphore arm from zero through an arc of [ninety (90)] degrees in [ten (10)] seconds at [one hundred and ten (110)] volts, [single] phase, [sixty (60)] cycles, consuming not more than $\left\{\begin{array}{ll} \text{commutating} & 200 \\ \text{induction} & 300 \end{array}\right\}$ volt-amperes with a power-factor of [seventy (70)] per cent. Starting and operating current at any point of the arc shall not exceed $\left\{\begin{array}{ll} \text{commutating} & 275 \\ \text{induction} & 550 \end{array}\right\}$ volt-amperes. 1912.

††(d) Holding device shall consume not more than [fifty (50)] volt-amperes with a power-factor of [forty (40)] per cent. at [one hundred and ten (110)] volts, [single] phase, [twenty-five or sixty (25 or 60)] cycles.

1912.

441. *Solenoid type.*

(a) Signal shall be of the solenoid type $\left\{\begin{array}{c} \text{high} \\ \text{low} \end{array}\right\}$ voltage holding device, operating mechanism located at ....

(b) Solenoid shall operate the semaphore arm from zero, through an arc of .... (..) degrees in .... (..) seconds at .... (..) volts, ... (..) phase, ... (..) cycles, consuming not more than .... (..) volt-amperes with a power-factor of .... (..) per cent. Starting and operating current at any point of the arc shall not exceed .... (..) amperes and .... (..) volt-amperes.

(c) Holding device shall consume not more than .... (..) volt-amperes with a power-factor of .... (..) per cent. at .... (..) volts, ... (..) phase, ... (..) cycles.

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††Note.—Attention is called to the use of *110* volt, single phase, *25 or 60* cycles, and the volt-amperes, power-factor and current, which form a proper basis for computing data required in a system of a different voltage and different frequency, should it be found desirable to depart from the suggestions as shown above.

442. *Electro-pneumatic type.*

Signals shall be of the electro-pneumatic type, operating mechanism located at ....

443. *Light type signals.*

Signals shall be of the electric light type, displaying $\left\{\begin{array}{l}\text{two}\\ \text{three}\end{array}\right\}$ aspects. Aspects shall be given by lenses .... (..) inches in diameter, each lens shall be illuminated by $\left\{\begin{array}{l}\text{one}\\ \text{two}\\ \text{....}\end{array}\right\}$ electric lamps. Each lamp shall be .... (..) candle-power at .... (..) volts and have a life of .... (..) lamp hours at .... (..) watts per candle-power.

CIRCUITS.

500. *Practice.*

Circuits shall comply with the Contractor's recommended practice unless otherwise specified.

501. *Switchboard circuits.*

Contractor's recommended arrangements of circuits shall be followed, subject to necessary modifications on account of special requirements.

502. *Track circuits.*

(a) Contractor shall provide .... track circuits as shown by the shaded tracks on Purchaser's drawing ...., dated .... The purpose of each track circuit will be indicated on the plan by one or more of the following letters:

A.—For control of annunciators.
B.—For control of automatic block signals.
C.—For control of highway crossing alarms.
D.—In place of or in addition to detector bars.
F.—For control of fouling point indicators.
R.—For control of route locks.
S.—For control of semiautomatic signals.

(b) Main track circuits shall be extended to the fouling point or derail on siding switches; on crossover track circuits shall be extended so as to provide as much fouling protection as can be obtained.

(c) Non-interlocked main line single switches, both switches of crossovers and siding derails between home and distant signals shall be equipped with switch circuit controllers.

504. *Signal circuits.*

....

....

....

506. *Electric lighting circuits.*

(a) Electric lights on signals shall be arranged on ... . (..) circuits as follows:

....

....

....

(b) The maximum allowable drop in potential on electric lighting circuits from switchboard to any lamp shall be ten (10) per cent.

510. *Special circuits.*

The Purchaser will here indicate in full detail all special circuit requirements.

....

....

....

WIRE AND WIRING.

520. *Specification.*

(a) Wire and cable shall comply with the specnfications of the Railway Signal Association.

(b) Cables built up at the site of work and all flexible conductors shall have three sixty-fourths (3/64) inch wall. 1912.

SIZE.

521. *Size.*

(a) Wires shall be of sufficient size to permit operation of signal mechanism in accordance with previous specifications.

(b) Rubber covered wire smaller than number fourteen (14) B. & S. gauge shall not be used.

(c) Signal control wire shall be number fourteen (14) or .... (..) B. and S. gauge $\left\{\begin{matrix}\text{solid}\\\text{stranded}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{bare}\\\text{insulated}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{copper}\\\text{......}\end{matrix}\right\}$ conductor. 1912.

(d) Main common wire shall be .... (..) B. & S. gauge and unless otherwise specified, shall be continuous without joints or breaks.

(e) In submarine cable work spare wires up to twenty-five (25) per cent. of the number in use shall be provided as specified. When spare wires are required in other than cable work the number and size shall be specified.

521. *Size.*—Continued.

(f) Numbers and sizes of track circuit connections shall be as follows:

	No. of conductors.	B. & S. gauge.
1. Transformers to rail....	one (1)	.... (..)
2. Relays to rail..........	one (1)	.... (..)
3. Fouling shunt connections	two (2)	.... (..)
4. Switch circuit controller connections	two (2)	.... (..)

1912.

(g) Wires connected to track shall be rubber-covered soft-drawn copper.

(h) Copper-clad steel wire shall not be smaller than number fourteen (14) B. & S. gauge.

(i) Number .... (..) B. & S. gauge wire shall be used for all connections from instrument to pole line or cable. 1912.

(j) Number .... (..) B. & S. gauge wire shall be used in main conduit. 1912.

(k) Number .... (..) B. & S. gauge wire shall be used for connections of motor to secondary of line transformer. 1912.

(l) Number .... (..) B. & S. gauge $\left\{\begin{matrix}\text{solid}\\\text{stranded}\end{matrix}\right\}$ wire shall be used in connecting lightning arresters and junction terminals. 1912.

522. *Cables for low voltage circuits.*

(a) Aerial cables shall have .... (..) $\left\{\begin{matrix}\text{solid}\\\text{stranded}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{copper}\\\text{......}\end{matrix}\right\}$ conductors, No. .... (..) B. & S. gauge and .... (..) No. .... (..) B. & S. gauge $\left\{\begin{matrix}\text{solid}\\\text{stranded}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{copper}\\\text{......}\end{matrix}\right\}$ conductors.

(b) Underground signal cables shall have .... (..) $\left\{\begin{matrix}\text{solid}\\\text{stranded}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{copper}\\\text{......}\end{matrix}\right\}$ conductors No. .... (..) B. & S. gauge and .... (..) No. .... (..) B. & S. gauge $\left\{\begin{matrix}\text{solid}\\\text{stranded}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{copper}\\\text{......}\end{matrix}\right\}$ conductors.

(c) Submarine cables shall have .... (..) $\left\{\begin{matrix}\text{solid}\\\text{stranded}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{copper}\\\text{......}\end{matrix}\right\}$ conductors No. .... (..)

522. *Cables for low voltage circuits.*—Continued.

B. & S. gauge and .... (..) No. .... (..) B. & S. gauge $\left\{\begin{matrix}\text{solid}\\\text{stranded}\end{matrix}\right\}\left\{\begin{matrix}\text{copper}\\\text{......}\end{matrix}\right\}$ conductors.

523. *Line wire for high voltage circuits.*

Signal transmission line shall be No. .... (..) B. & S. gauge $\left\{\begin{matrix}\text{solid}\\\text{stranded}\end{matrix}\right\}\left\{\begin{matrix}\text{....bare}\\\text{....insulated}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{copper}\\\text{......}\end{matrix}\right\}$ conductor.

524. *Cables for high voltage circuits.*

(a) Aerial signal transmission cables shall have .... (..) $\left\{\begin{matrix}\text{solid}\\\text{stranded}\end{matrix}\right\}\left\{\begin{matrix}\text{copper}\\\text{......}\end{matrix}\right\}$ conductors No...... ...... (..) B. & S. gauge and ...... (..) No. ...... (..) B. & S. gauge $\left\{\begin{matrix}\text{solid}\\\text{stranded}\end{matrix}\right\}\left\{\begin{matrix}\text{copper}\\\text{......}\end{matrix}\right\}$ conductors.

(b) Underground signal transmission cables shall have ..... (..) $\left\{\begin{matrix}\text{solid}\\\text{stranded}\end{matrix}\right\}\left\{\begin{matrix}\text{copper}\\\text{......}\end{matrix}\right\}$ conductors No...... ...... (..) B. & S. gauge and ...... (..) No. ...... (..) B. & S. gauge $\left\{\begin{matrix}\text{solid}\\\text{stranded}\end{matrix}\right\}\left\{\begin{matrix}\text{copper}\\\text{......}\end{matrix}\right\}$ conductors.

(c) Submarine signal transmission cables shall have ..... (..) $\left\{\begin{matrix}\text{solid}\\\text{stranded}\end{matrix}\right\}\left\{\begin{matrix}\text{copper}\\\text{......}\end{matrix}\right\}$ conductors No...... .... (..) B. & S. gauge $\left\{\begin{matrix}\text{solid}\\\text{stranded}\end{matrix}\right\}\left\{\begin{matrix}\text{copper}\\\text{......}\end{matrix}\right\}$ conductors.

525. *Wiring.*

(a) Wires in trunking, chases or conduits shall be laid loosely without stretching or crowding.

(b) Not more than two (2) wires shall be connected to one (1) binding post or terminal screw.

526. *Common return.*

(a) Reductions in size of common wire and connections to pole lines shall be made in junction boxes.

(b) Connections between branches and main common wires shall be made in junction boxes.

527. *Joints in wire.*

(a) Wires shall, as far as practicable, be continuous without joints or breaks; joints shall be made only on permission from the Engineer.

527. *Joints in wire.*—Continued.

(b) In making joints, braid shall be pulled back one (1) inch from end of rubber on each side of splice, and rubber cut with knife held at an angle of approximately thirty (30) degrees with axis of wire, as one would sharpen a pencil.

(c) After removing rubber, wire shall be thoroughly cleaned, care being taken to prevent injury from small cuts or nicks.

(d) Wire, after being cleaned, shall be twisted together in the form of a regular line wire splice, turns being spaced approximately one-sixty-fourth (1/64) inch.

(e) Joints shall then be soldered by pouring on them, or dipping them into, melted solder, a noncorrosive rosin flux being used. After soldering, joints shall be painted with .... insulating paint or with .... compound.

(f) Joints shall then be covered with two (2) layers of .... insulating tape between ends of braid, which tape shall be heated sufficiently to form a tight covering, but not enough to injure the quality of the material. Coating of .... insulating paint or .... compound shall be put on over insulating tape and two (2) layers of .... adhesive or friction tape shall be applied, after which the outside of the joint shall be painted with .... insulating paint.

528. *Fuses.*

Material.

(a) Fuses shall be of the enclosed type.

Field work.

(b) The necessary fuses to properly protect all apparatus and circuits shall be installed.

(c) Fuses outside of buildings shall be enclosed in weatherproof boxes.

(d) In the lighting circuits, a fuse shall be provided in the circuit to each signal lamp; in the circuit to each set of lamps on a mast; in each branch circuit leaving the mains, and in each set of mains leaving the switchboard.

530. *Tags.*

Material.

(a) Tags shall be made of vulcanized sheet fibre, not less than one-sixteenth (1/16) inch thick, firmly attached to the wire by the best quality yacht marline one-sixteenth (1/16) inch in diameter.

(b) The tag shall have a stamped imprint to show the function of the wire.

530. *Tags.*—Continued.

Field work.

(c) Wires shall be tagged at all junction boxes, switches, signals, relay boxes, arrester boxes, and at all line wire connections, unless otherwise specified.

532. *Petroleum asphaltum.*

Material.

(a) Petroleum asphaltum shall comply with specifications of the Railway Signal Association for "Petroleum Asphaltum."

Field work.

(b) When specified, the wires in the trunking shall be loosely bound and shall be so laid in pitch as to be practically free of contact with all walls of the trunking.

(c) When petroleum asphaltum is used, terminal box bootlegs, trunking and bootleg terminals shall be in accordance with Railway Signal Association drawings 1154, 1155, 1156 and 1157.

BONDING.

(Where propulsion, bonding is not required.)

540. *Bonding wires.*

Material.

(a) Bonding wires shall comply with Railway Signal Association specification for "Bonding Wires."

Field work.

(b) Number six (6) B. & S. gauge bare copper or copper-clad steel bonding wires shall be used.

(c) Bonding shall be in accordance with .... drawing .... Rail joints, except as below, shall be bonded with two (2) number six (6) B. & S. gauge bonding wires. Where joints are located in platforms or road crossings, whether of plank, brick, or ballast filling, four (4) wires must be used at each joint, two (2) being placed on either side of rail and outside of angle bar.

(d) Frogs shall be bonded in the same manner as the rail joints and shall be so connected, that the continuity of the track circuit will be broken when they are removed from the track.

542. *Channel pins.*

Material.

(a) Channel pins shall comply with the specifications of the Railway Signal Association for "Channel pins."

Field work.

(b) Each bond wire shall be fastened at each end into the web of the rail by a channel pin.

(c) Channel pins shall be driven the same day that holes are drilled.

IMPEDANCE BONDS.

543. *Impedance bonds.*

(a) Core bonds shall comply with Railway Signal Association specifications.

(b) Coreless bonds shall have a continuous capacity of .... (..) amperes of propulsion current and shall not consume more than .... (..) amperes at .... (..) volts of signal current at .... (..) cycles.

CONTROL APPARATUS.

600. *Relays.*

Alternating current relays shall be in accordance with .... specifications.

601. *Line circuit relays.*

Line circuit relays shall consume not more than [fifteen (15)] volt-amperes with a power-factor of [seventy (70)] per cent. at [one hundred and ten (110)] volts, [single] phase, [twenty-five or sixty (25 or 60)] cycles, equipped with [four (4)] fingers, [four (4)] front and [two (2)] back contacts. Front contacts shall carry [five (5)] amperes continuously and break [ten (10)] amperes at [one hundred and ten (110)] volts; back contacts shall carry [five (5)] amperes continuously and break [ten (10)] amperes at [one hundred and ten (110)] volts.

1912.

602. *Track circuit relays.*

††(a) Track circuit relays receiving all of their energy over track rails, shall consume not more than [fifteen (15)] volt-amperes with a power-factor of [seventy (70)] per cent. at [three (3)] volts, [single] phase, [twenty-five or sixty (25 or 60)] cycles, equipped with [four (4)] fingers, [four (4)] front and [two (2)] back contacts. Front contacts shall carry [five (5)] amperes continuously and break [ten (10)] amperes at [one hundred and ten (110)] volts; back contacts shall carry [five (5)] amperes continuously and break [ten (10)] amperes at [one hundred and ten (110)] volts. 1912.

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††Note.—Attention is called to the use of *110* volt, single phase, *25 or 60* cycles, and the volt-amperes, power-factor and current, which form a proper basis for computing data required in a system of a different voltage and different frequency, should it be found desirable to depart from the suggestions as shown above.

602. *Track circuit relays.*—Continued.

(b) Track circuit relays receiving part of their energy from track rails and part from another source, shall consume on the track winding not more than .... volt-amperes, with a power-factor of .... per cent. at ....volts, ... phase, ... cycles. The winding energized from the other source shall consume not more than .... volt-amperes with a power-factor of .... per cent. at .... volts, ... phase, ... cycles, equipped with [four (4)] fingers, [four (4)] front and [two (2)] back contacts. Front contacts shall carry [five (5)]amperes continuously and break [ten (10)] amperes at [one hundred and ten (110)] volts; back contacts shall carry [five (5)] amperes at [one hundred and ten (110)] volts. 1912.

610. *Circuit controllers.*

Material.

(a) Circuit controller of substantial construction and positive in action shall be provided for track switches as specified and shall be so constructed that they can be maintained to make or break circuit when switch point shall be moved from the closed position three-sixteenths (3/16) of an inch.

(b) Operating rods of switch circuit controllers shall be not less than five-eighths (5/8) inch in diameter and adjustable, with a maximum distance of three (3) feet between supports.

(c) Circuit controllers for non-interlocked switches shall have two independent shunt connections to the track circuit of each track affected by the opening of the switch.

(d) Lever and latch circuit controllers shall have .... (..) fingers .... (..) normally open and .... (..) closed contacts.

(e) Circuit controllers for switch points, movable point frogs or derails shall have .... (..) fingers with .... (..) normally open and .... (..) closed contacts.

(f) Drawbridge circuit controllers shall have .... (..) fingers with .... (..) normally open and .... (..) closed contacts.

(g) Circuit controllers for mechanically interlocked signals shall have .... (..) fingers with .... (..) open and .... (..) closed contacts.

610. *Circuit controllers.*—Continued.

Field work.

(h) The switch circuit controller shall be positively connected to one or both points; if but one point, the normally .... shall be selected.

(i) The switch circuit controller shall be insulated from the tie plate and from the track.

615. *Electric locks for hand-operated track switches.*

(a) Electric locks shall be in accordance with .... specifications.

††(b) Electric locks shall consume not more than [thirty (30)] volt-amperes with a power-factor of [seventy (70)] per cent. at [one hundred and ten (110)] volts, [single] phase, [twenty-five or sixty (25 or 60)] cycles, and shall have [four (4)] fingers with [two (2)] normally open and [four (4)] closed contacts. All contacts shall carry [five (5)] amperes continuously and break [ten (10)] amperes at [one hundred and ten (110)] volts. 1912.

618. *Hand releases.*

....
....
....

622. *Time locks.*

....
....
....

625. *Switch indicators.*

(a) Switch indicators shall be in accordance with .... specifications.

††(b) Switch indicators shall consume not more than [fifteen (15)] volt-amperes with a power-factor of [seventy (70)] per cent. at [one hundred and ten (110)] volts, [single] phase, [twenty-five or sixty (25 or 60)] cycles. 1912.

††(c) Switch indicators shall consume not more than [twenty (20)] volt-amperes with a power-factor of [seventy (70)] per cent. at [one hundred and ten (110] volts, [single] phase, [twenty-five or sixty (25 or 60)]

---

††Note.—Attention is called to the use of *110* volt, single phase, *25 or 60* cycles, and the volt-amperes, power-factor and current, which form a proper basis for computing data required in a system of a different voltage and different frequency, should it be found desirable to depart from the suggestions as shown above.

625. *Switch indicators.*—Continued.

cycles, equipped with [four (4)] fingers, [four (4)] front and [two (2)] back contacts. Front contacts shall carry [five (5)] amperes continuously and break [ten (10)] amperes at [one hundred and ten (110)] volts. Back contacts shall carry [five (5)] amperes continuously and break [ten (10)] amperes at [one hundred and ten 110)] volts. 1912.

635. *Lightning arresters.*

Material.

(a) Lightning arresters of .... design shall be used at all aerial line connections.

(b) Lightning arresters for high tension line shall be in accordance with .... specifications.

TRUNKING, CONDUITS AND SUPPORTS.

700. *Trunking.*

Material.

(a) Grooved trunking, built up trunking and all capping shall be .... lumber and comply with the Railway Signal Association specification for "Wood trunking."

(b) The dimensions for trunking shall comply with Railway Signal Association drawings 1176 or 1177.

(c) Treated trunking shall be used when specified, and shall comply with the attached requirements as to treatment.

Field work.

(d) The location of the main runs of trunking is shown on .... drawing ....

(e) Permission shall be obtained to place between tracks runs of trunking parallel with the tracks.

(f) Trunking, when on stakes above ground and running parallel with the track, shall not be placed nearer than six (6) feet from the gauge side of the nearest rail except by special permission.

(g) Local conditions shall determine the height of trunking when above ground; in general, when trunking is run parallel with the tracks, bottom of trunking shall be placed approximately six (6) inches above ground.

(h) Drainage of the trunking shall be provided as follows:

....

....

....

(i) Nails shall not be driven through the trunking from the inside of the groove nor shall they be driven into the groove from the outside.

700. *Trunking.*—Continued.

(j) Inside corner of trunking, at turns, must be rounded to prevent insulation on wires being injured.

(k) Surfaces of trunking that are to be painted shall be finished.

(l) Not less than one-third (1/3) of the capacity of the groove shall remain free for the further installation of wires.

(m) As specified, capping shall be securely fastened to trunking with $\left\{\begin{array}{c}\text{gate hooks.}\\\text{nails.}\end{array}\right\}$ Gate hooks may be used on main runs of trunking and nails on cross leads.

703. *Joints in trunking.*

(a) Unless otherwise specified, joints in grooved trunking shall be lapped, the ends of trunking being beveled at an angle of forty-five (45) degrees.

(b) Joints in built up trunking shall be staggered.

(c) Joints in capping shall be made at least one (1) foot from joints in trunking.

705. *Trunking supports.*

Material.

(a) Stakes shall be made of .... three (3) inches by four (4) inches, or of equivalent circular section and of sufficient length to allow them to be placed at least two (2) feet in the ground. When, due to local requirements, stakes of a greater length than three (3) feet six (6) inches, or a greater cross section than three (3) inches by four (4) inches will be necessary, information as to the number, length and cross section will be furnished by the Purchaser to the Contractor.

Field work.

(b) Trunking above ground shall be supported on stakes placed not more than five (5) feet centers.

(c) When trunking exceeds a width of seven (7) inches a special arrangement consisting of $\left\{\begin{array}{c}\text{a double line of stakes}\\\text{a single line of large stakes}\end{array}\right\}$ shall be installed, or provision shall be made as follows:........................
....
....

(d) Stakes supporting trunking shall be placed vertically and extend at least two (2) feet below the surface of the ground, unless otherwise specified.

705. *Trunking supports.*—Continued.

(e) A piece of capping eight (8) inches long and the width of the trunking shall be placed between the trunking and each stake.

(f) Each joint in the bottom of the trunking shall be supported by a stake.

708. *Bootlegs.*

Bootlegs for track connection shall be made in accordance with .... drawing .... They shall be securely fastened to the trunking, not less than two (2) inches from base of rail, and shall not extend more than one (1) inch above base of rail.

710. *Junction boxes.*

Material.

(a) Junction boxes shall be made of .... and so designed that terminals will be kept dry. Each junction box shall be fitted with a cover, hasp and staple.

(b) Where ten (10) or less wires are used, junction boxes shall be sixteen (16) inches square by twenty (20) inches deep, inside dimensions, and shall be increased six (6) inches in length for each ten (10) additional connections or fraction thereof made in the box.

Field work.

(c) Junction boxes shall be located as shown on .... drawing .... and at a height sufficient to allow terminals to be placed at least six (6) inches above top of trunking.

(d) Junction boxes shall be supported in the same manner as the trunking.

711. *Conduits.*

(a) Fibre conduit shall comply with Railway Signal Association's specifications.

(b) Vitrified clay conduits shall comply with Railway Signal Association's specifications.

LINE CONSTRUCTION.

714. *Line construction.*

Line construction shall comply with local laws. 1912.

715. *Supports for line.*

(a) Line wire shall be supported by cross arms, pins and insulators.

(b) Cross-arms shall be in accordance with Railway Signal Association's specifications for "Cross-arms."

(c) Cross-arm pins, braces, lags, through bolts, double arming bolts, and insulators shall be in accordance with Railway Signal Association's specifications for "Cross-arm Pins."

715. *Supports for line.*—Continued.

(d) Special bracket and insulators shall be in accordance with .... drawing ....

(e) Aerial cable shall be supported by messenger wire. Messenger wire shall be supported by L clamps which will be furnished in place by ....

(f) Cable shall be supported on messenger wire by hooks and marlin loops or by ....

(g) Line wire supports shall be furnished in place by ....

717. *Supports for high voltage cable.*

(a) Messenger wire shall be .... (..) inches in diameter and in accordance with .... specifications.

(b) Messenger wire fixtures shall be in accordance with .... drawing ....

718. *Cable boxes.*

(a) Cables shall terminate in cable boxes in accordance with .... drawing ....

(b) Cable boxes shall be furnished in place by ....

INSTRUMENT SHELTER.

720. *Relay boxes.*

Material.

(a) Relay boxes at signals and track circuit limits shall be in accordance with .... drawing ...., and shall be made of $\left\{\begin{array}{c}\text{wood}\\ \text{wood lined}\\ \text{cast iron}\end{array}\right\}$

Field work.

(b) Terminals for relay boxes at signal locations shall be arranged in accordance with ....drawing ....

(c) Terminals in boxes at track circuit limits shall be arranged in accordance with .... drawing ....

721. *Relay cases.*

Relay cases for interlocking stations shall be in accordance with .... drawing .... and shall be neatly finished and dustproof.

722. *Lightning arrester boxes.*

Boxes for housing lightning arresters shall be in accordance with .... drawing ....

723. *Transformer shelters.*

....
....
....

724. *Grid or unit resistance shelters.*

....
....
....

INSULATIONS.

735. *Insulated rail joints.*

Material.

(a) Insulated rail joints shall be in accordance with .... drawing ....

Field work.

(b) Both rails shall be insulated at fouling points, ends of track circuits and in switch leads.

(c) Rail joints shall be installed by the Purchaser at joints designated by the ....

738. *Switch rod insulations.*

Material.

(a) Switch rod insulations shall be in accordance with .... drawing ....

Field work.

(b) Insulations for switch rods shall be installed by the Purchaser at points designated by the ....

(c) Switches to be insulated are equipped with .... (..) switch rods, ... (..) inches by .... (..) inches cross section, as shown on .... drawing .... except as noted on .... drawing ...., dated ....

742. *Pipe line insulation.*

Material.

(a) Pipe line insulation shall be in accordance with Railway Signal Association drawing 1094.

Field work.

(b) Pipe line insulations shall be installed by the ....

744. *Tie plate insulations.*

Material.

(a) Tie plate insulations shall be in accordance with.. .... drawing ....

744. *Tie plate insulations.*—Continued.

Field work.

(b) Insulated tie plates shall be installed by the ......
....

748. *Insulating fibre.*

Insulating fibre shall comply with Railway Signal Association specifications for "Hard fibre."

PAINTING.

800. *Paint.*

Material.

(a) Purchaser will indicate here the kind of paint that shall be required:

....
....
....

Field work.

(b) Surfaces covered with rust, grease, dirt or other foreign substances, shall be thoroughly cleaned before paint or oil is applied.

(c) Paint shall not be applied to outside surfaces in freezing weather, nor to wet surfaces, nor until previous coating has thoroughly dried.

(d) Finishing coats shall not be applied until after the expiration of forty-eight (48) hours after the previous coating has been applied.

(e) Paints mixed on the ground shall be applied within three (3) hours after the pigment and oil are mixed.

(f) Priming coats shall be applied as soon as is consistent with the progress of the work.

(g) Second coat shall be applied in sufficient time for the third coat to be applied and dry when the installation is completed.

810. *Iron work.*

(a) Iron work (except tie plates and air pipe line) not galvanized shall be painted one (1) coat of red lead and raw linseed oil and two (2) finishing coats.

(b) The following specific finishing coats shall be used:

	Kind of paint.	Color.
Signal bridges and brackets	....	....
Signal masts	....	....

830. *Wood work.*

Exposed wood work shall be given one (1) priming coat and finishing coats as follows:

	Kind of Paint.	Color.	Number of coats.
Home signal blades	....	....	......(..)
Distant signal blades	....	....	......(..)
Trunking, junction boxes, etc.	....	....	......(..)

840. *Buildings.*

Power house or other buildings constructed of wood shall receive one (1) priming coat and two (2) finishing coats. The priming coat shall consist of .... and when thoroughly dry two (2) coats of .... in the following tints, shall be applied:

....

....

....

SPECIAL ITEMS.

900.

....

....

....

925. *Locks.*

Purchaser's standard locks shall be used when specified.

826. *Number plates and numbers.*

(a) *Number plates.*

....

....

....

(b) *Numbers.*

....

....

....

928. *Junction terminals.*

Junction terminals shall be in accordance with Railway Signal Association drawing 1055.

SPECIFICATIONS AND REQUISITES OF APPARATUS AND MATERIAL FOR ALTERNATING CURRENT AUTOMATIC BLOCK SIGNAL SYSTEM.

(On all railways except those using d.c. or a.c. for propulsion.)

1912.

To be installed at..
on the.......................................R.............................

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SPECIFICATIONS AND REQUISITES OF APPARATUS AND MATERIAL FOR ALTERNATING CURRENT AUTOMATIC BLOCK SIGNAL SYSTEM.

(On all railways, except those using direct or alternating current for propulsion.)

1912.

GENERAL PROVISIONS.

1. *Purpose.*

(a) The purpose of these specifications is to describe all the materials to be furnished, all the work to be performed and the method of construction for a complete installation in every detail, in strict accordance with the drawings and specifications hereto attached and such instructions as may, from time to time, be given by the Purchaser; and it is hereby understood that the Contractor agrees to furnish any and everything obviously necessary for such complete installation except that specifically stated as being furnished by the Purchaser.

(b) The purpose of the installation is ....
....

2. *Contract.*

As soon as possible after the award is made........... (..) copies of contract, in accordance with the accompanying form, will be presented to the Contractor for signature, after which all copies will be signed by the Purchaser and one will be returned to the Contractor.

3. *Drawings*

(a) Purchaser's drawings. Drawings accompanying the specifications and forming an essential part thereof are as follows:

1. Drawing ...., dated ...., scale one (1) inch equals .... (..) feet, showing the arrangement of tracks, grades, curvature, the location of interlocking stations, power stations, trunking lines, pipe lines, air reservoirs, valves, location of existing and proposed signals, switches, derails, crossovers, detector bars, steam and electric railway crossings, highway crossings, highway crossing alarms, track circuit limits, trestles, stations, station platforms, pole line or other supports for line wires or aerial cables, approximate number of poles per

3. *Drawings.*—Continued.

mile, average distance of nearest pole from each signal or relay box to which line wire connections are required, and notation showing the section of rail and drilling of rail joints where such information is necessary.

2. Drawing ...., dated ...., showing typical circuits for the control of power operated signals, switch indicators, protection for facing and trailing switches, main line and siding crossovers, highway crossing alarms, train order signals and ....
....
....

3. Drawing ...., dated ...., showing typical circuits for approach locking, route locking, track circuits and the control of annunciators, indicators, repeaters, and ....
....

4. Drawing ...., dated ...., showing location of junction posts and .... for typical signal and relay locations.

5. Purchaser's standard drawings effecting this installation are to be listed above and identified by drawing numbers and descriptions.

(b) Contractor's drawings. Drawings accompanying the proposal and forming an essential part thereof are as follows:

1. The Contractor shall furnish, with his proposal, drawings or catalogue reference for apparatus he proposes to furnish, which is not covered by the drawing furnished by the Purchaser.

2. Not less than .... (..) days after the award of the contract, and before work is begun, the Contractor shall furnish, for the approval of the Purchaser, the following drawings:
....
....
....
Not more than .... (..) days after the receipt of these drawings the Purchaser will indicate any corrections that may be necessary or signify his approval.

(c) After the contract is awarded each party shall furnish to the other necessary prints of his approved drawings.

4. *Changes in specifications by Purchaser.*

The Purchaser, when inviting proposals from the Contractor, shall specify any deviation from the detail specifications and shall enumerate fully details left optional in these specifications, giving all necessary information to the Contractor, and the Purchaser may substitute such specifications or any part thereof for like portions of these specifications.

5. *Contractor's supplemental specifications.*

With the proposal the Contractor may submit detailed specifications covering apparatus he proposes to furnish.

6. *Material and workmanship.*

(a) Material and workmanship shall be first class in every respect.

(b) Contractor shall replace, at his own cost, any part or parts of the apparatus and material furnished by him under this contract which shall, within a period of one (1) year, fail to perform its proper function because of any defect in the construction, application or erection of such apparatus.

7. *Materials to be furnished and work to be done by and at the expense of the Purchaser.*

(a) Furnish ties in place for support of apparatus and move ties which interfere with installation of apparatus or connections.

(b) Move all switch and tie rods necessary for the placing of apparatus.

(c) Furnish track, bridge, switch rod, tie rod, tie plate and rail insulations in place.

(d) Furnish concrete materials.

(e) Do grading necessary for the placing of foundations and apparatus, provide drainage necessary for the proper maintenance of the plant and excavate solid rock where necessary.

(f) Furnish cross arms, pins, insulators and line wire in place.

(g) Furnish battery wells in place.

(h) Furnish signal bridges in place.

(i) Furnish aerial and submarine cable and terminal boxes for the same in place.

(j) Apply necessary attachments to signal apparatus that is in service.

(k) Make necessary alterations of any part of existing structures.

7. *Materials to be furnished.*—Continued.

(l) Unload and properly house material that arrives on the ground before the Contractor's force, this work to be done under the direction of the Contractor's representative.

(m) Obtain necessary permits from state and municipal authorities.

(n) Furnish switches, derails and movable point frogs in place, adjusted to the required throw.

(o) Except as otherwise specified, furnish tools, fixtures for buildings and supplies required for the maintenance of the plant.

(p) Furnish submarine pipe line in place.

8. *Shipment of material.*

Material shall be shipped to .... care of .... marked for .... Material shipped from Contractor's factory at ...., shall be shipped via .... and thence via .... to destination.

9. *Precautions and use of hand and other cars.*

(a) The Contractor shall place sufficient and proper guards for the prevention of accidents, and shall put up and maintain, at night, suitable and sufficient lights.

(b) The Contractor shall do no work that may interfere with traffic until protection has been provided by the Purchaser.

(c) The Purchaser will promptly arrange to protect traffic upon request of the Contractor.

(d) The use of the following cars will be permitted in accordance with the attached regulations:

	Number	Furnished by
Motor cars	.......(...)	....
Velocipede cars ..	.......(...)	....
Hand cars	.......(...)	....
Push cars	.......(...)	....

(e) When the Contractor is not permitted to use hand or push cars, the Purchaser will, at his own expense, distribute material to the point of use upon receipt of notification from and under the supervision of Contractor's foreman.

10. *Inspection of material.*

Materials at any time before installation shall be subject to the inspection of the Purchaser's accredited representative.

11. *Supervision.*

The installation shall be made under the supervision and to the satisfaction of the Purchaser's accredited representative, hereinafter referred to as the Engineer.

12. *Completion.*

When the installation is complete the apparatus and the surface of the ground which has been effected by the installation shall be left in a neat and clean condition.

13. *Inspection of installation*

Contractor shall advise the Purchaser .... (..) days in advance of the time the installation will be completed and ready for final inspection. The Purchaser will make final inspection and test within .... (..) days after the completion of the work to insure that the work has been completed in conformity with the specifications.

14. *Placing in service.*

(a) After receipt of written authority from the Purchaser, the Contractor shall place the installation in service under the supervision of the Purchaser, and shall leave .... (..) competent men on duty for ... . (..) days thereafter.

(b) Purchaser will place the installation in service in the event that he does not authorize the Contractor to do so within .... (..) days after the completion of the work to the Purchaser's satisfaction.

(c) Signal indications shall be displayed or changed only as authorized by the Purchaser.

(d) After the installation has been placed in service, the indication displayed by a signal shall be changed only as authorized by the Purchaser.

15. *Acceptance.*

After the installation has been operating satisfactorily in regular service .... (..) days and before final payment will be made, the Purchaser will give the Contractor a written acceptance of the installation.

16. *Changes and additions.*

(a) Changes and additions, as provided for in the contract, shall be made in accordance with these specifications.

(b) Additional work within the scope of the contract shall be done on the basis of the unit prices as stated in the contract.

17. *Alternative proposals.*

The proposals must meet the requirements of the specifications; however, if a bidder wishes to vary from the specifications or drawings, an alternative proposal may be submitted. Full information must be furnished with the alternative proposal to show wherein the requirements of these specifications are not met.

18. *Transportation.*

Purchaser $\left\{\begin{array}{c}\text{will}\\ \text{will not}\end{array}\right\}$ furnish free transportation for men, tools and material necessary for the installation over the following lines ....
....

20. *General electric requirements.*

(a) Electric apparatus shall withstand an insulation test at the place of manufacture of three thousand (3000) volts a. c. for one (1) minute.

(b) Magnets and solenoids shall be plainly marked with their resistance and the size of wire with which they are wound.

(c) Windings shall be treated in accordance with Railway Signal Association specifications for "Impregnation treatment for coils and windings."

DETAIL PROVISIONS.

50. *Building foundations.*

.... foundations for the buildings shall be furnished in place by the .... in accordance with specifications and drawings ...., dated ...
....

52. *Power house.*

A .... building .... (..) stories high and .... by .... inside dimensions, shall be erected by the .... in accordance with .... specifications and drawings ....
.........., dated ....

53. *Housing for gasoline tank.*

Housing for gasoline tank as per drawing ...., dated ...., located not less than .... (..) feet from the power house, shall be constructed by
....

54. *Lighting for buildings.*

(a) The lighting for buildings shall be installed by
....

(b) The number, kind, size and distribution of electric lights, when used, shall be as follows:

54. *Lighting for buildings.*—Continued.

Room.	Number.	Candle power.	Location and description.
Upper story	....(..)	...(..)	....
Lower story	....(..)	...(..)	....
Generator room	....(..)	...(..)	....
Special	....(..)	...(..)	....

(c) Lights shall be controlled by switches located as follows:

Number.		Location.
....	(..)	....
....	(..)	....
....	(..)	....
....	(..)	....

(d) Fixtures for electric lights {will / will not} be required. When required, they will be provided by the Purchaser and installed by the Contractor.

(e) The electric lights and accessories shall be acceptable to and installed under the rules of the National Board of Fire Underwriters and the attached requirements of the local authorities.

POWER PLANT.

60. *Plant.*

The power plant shall consist of .... engine .... connected to .... motor .... connected to .... generator .... transformer together with .... mercury arc rectifier .... charging rheostat .... operating switch board .... motor starting panel, all in accordance with detailed specifications herein, and shall be installed by the .... in the locations provided by the ....

61. *Engine.*

(a) A .... (..) cylinder, ... (..) cycle, {vertical / horizontal / turbine} .... engine of .... (..) brake horsepower manufactured by .... installed by the ...., shall be furnished on a .... foundation to be furnished in place by the ...., constructed in accordance with the standard specifications of the .... and drawings of the Manufacturer of the engine numbers ...., dated ....

(b) A complete set of wrenches shall be furnished.

61. *Engine.*—Continued.

(c) Detail specifications of engine to be used are attached.

(d) The engine should be of such type as to be easily accessible for attention to bearings, adjusting and cleaning.

62. *Gasoline engine.*

The gasoline engine, fuel and water tanks shall comply with the specifications of the Railway Signal Association for "Gasoline engine with fuel and water tanks."

63. *Air compressor.*

A $\left\{\begin{matrix}\text{one}\\ \text{two}\end{matrix}\right\}$ stage air compressor of .... (..) indicated horsepower, capacity of .... (..) cubic feet of free air per minute at .... (..) feet elevation above sea level, and designed for air pressure of .... (..) pounds, manufactured by .... , installed by the ...., shall be furnished on a .... foundation, to be furnished in place by the ...., constructed in accordance with the standard specifications of the ...., and drawings of the Manufacturer.

65. *Generator.*

The electric generator shall comply with the specifications of the Railway Signal Association covering "Electric generator."

70. *Motor.*

The motor shall be .... (..) horsepower, with a rated speed not to exceed .... (..) r. p. m., if direct current, or one thousand eight hundred (1800) r. p. m., if alternating current, and shall have automatic regulation to within twenty (20) per cent., when operating on .... (..) to .... (..) volts d. c., or on .... (..) to .... (..) volts .... (..) cycles .... (...) phase a. c., shall comply with Railway Signal Association specifications for "Electric generators" regarding heating, sparking and insulation, and shall be furnished with a starting panel.

75. *Motor generator.*

Motor generators shall be direct connected, mounted on a cast iron sub-base and shall conform to the specifications for motors and generators (Sections 65 and 70).

SUPPLY AND DISTRIBUTION.

76. *Main supply.*

(a) The .... will provide .... and .... by which to generate or transform, or both, the power required for the signal transmission line. Switchboards will be provided by .... and located .... Lightning protection for main transformers and switchboards will be provided by ....

(b) Current shall be furnished .... and delivered to or at .... at .... (..) phase .... (..) cycles .... (..) volts. Watt hour meters will be installed by .... to read at ...., energy consumed by signal system.

(c) The main transformers shall be wired ...., located ...., and shall be in accordance with .... specifications. These will .... be provided with emergency cut-outs on their high potential side, and will .... be protected by fuses on their high potential side.

(d) The normal load on the signal transmission line at a point adjacent to the place of delivery shall be approximately .... (..) K. V. A., ... (..) K. W. This load will increase to .... (..) K. V. A., ... (..) K. W., to last .... (..) minutes, after interruption.

(e) The drop in voltage under normal conditions between the source of power supply and the far end of any feeder shall not exceed .... (..) per cent., and shall not be such as to interfere with the proper clearing of the signals when power is restored to the line.

(f) Power for operating signals shall be obtained from secondary of line transformer at .... (..) volts, with .... (..) per cent. allowable variation.

(g) Power for operating signals shall be obtained direct from secondary of line transformer or by the use of additional transformers, at .... (..) volts, with .... (..) per cent. allowable variation.

(h) Power for operating line circuit relays and indicators shall be obtained from secondary of line transformer at .... (..) volts, with .... (..) per cent. allowable variation.

76. *Main Supply.*—Continued.

(i) Power for signal lighting shall be obtained from secondary of line transformer or .... at .... (..) volts, with .... (..) per cent. allowable variation.

(j) Power for track circuits may be obtained from special secondary winding of line transformer at .... (..) volts, with .... (..) per cent. allowable variation, or from secondary of auxiliary transformer.

(k) Transformers shall be in accordance with .... specifications.

(l) Impedance coils shall be in accordance with .... specifications.

SECONDARY SUPPLY.

77. *Secondary supply.*

(a) Secondary supply shall be .... power, provided by .... at .... Change in supply to be made by ....

(b) The specifications for main supply apply to secondary supply.

80. *Transformers.*

Transformers shall comply with the specifications of

$$\left\{\begin{array}{l}\text{Railway Signal Association}\\ \text{........................}\\ \text{........................}\end{array}\right\}\text{ for “Transformers.”}$$

90. *Switchboards.*

Switchboards with fittings shall comply with the specifications of the Railway Signal Association, for "Switchboards."

95. *Condensers.*

(a) Condensers are of two (2) types, atmospheric and water cooled. The former is usually ample for plants using two hundred (200) cubic feet of free air per minute, at a pressure of ninety (90) pounds per square inch or less. The latter is to be preferred when high pressure or greater volume is used, while a combination of both may be justifiable where extreme pressure and unusual volumes prevail.

(b) As close to the compressor as practicable .... atmospheric after coolers having a circulating area of at least twice that of the discharge pipe of the compressor and a radiating surface of .... (..) square feet per cubic foot capacity of compressor, with .... (..) auxiliary tanks shall be furnished on a .... foundation, over a .... pit, for the auxiliary tanks, by the .... constructed

95. *Condensers.*—Continued.

in accordance with .... specifications. Each auxiliary tank shall be equipped with a blow out pipe extending from the bottom of the tank.

(c) A water after cooler having a circulating area of at least that of the discharge pipe of compressor and a radiating surface of .... (..) square feet per cubic foot capacity of compressor shall be furnished on a .... foundation, by the ...., constructed in accordance with the .... specifications. There shall be a by-pass .... (..) inches in diameter around the water cooler.

DISTRIBUTING SYSTEM.

98. *Air pipe line.*

Material.

(a) The main air pipe shall be galvanized best quality wrought iron pipe .... (..) inches diameter.

(b) The branch air pipe shall be galvanized wrought iron pipe, one-half (1/2) inch to supply signals and one-fourth (1/4) inch to supply relays.

(c) Expansion joints for main pipe .... (..) inches in diameter shall have an iron body, a brass sleeve and allowance made for .... (..) inches expansion.

(d) Gate valves shall have $\left\{\begin{matrix}\text{brass}\\ \text{iron}\end{matrix}\right\}$ body, brass seat $\left\{\begin{matrix}\text{stationary}\\ \text{rising}\end{matrix}\right\}$ stem, screw ends for .... (..) inch wrought iron pipe, and designed for a working pressure up to one hundred and fifty (150) pounds per square inch.

(e) Stop cocks, screw unions, combination stop cocks and screw unions shall be provided with brass seats, and designed for a working pressure up to one hundred and fifty (150) pounds per square inch.

(f) Pipe bends shall be galvanized wrought iron pipe .... (..) inches diameter and bent to form an arc of not less than .... (..) inches radius. Bends of a radius less than thirty (30) times the diameter of the pipe shall be formed before they are galvanized.

(g) Armored hose shall be of the best quality, ... (..) by .... (..), inch hose, capable of withstanding a pressure of one hundred and fifty (150) pounds per square inch.

98. *Air pipe line.*—Continued.

(h) Ells, nipples, tees, reducers and other iron pipe fittings must be galvanized.

(i) Flange unions shall be of $\left\{\begin{matrix}\text{wrought}\\\text{malleable}\end{matrix}\right\}$ iron with lead gaskets and brass or bronze seats.

Field work.

(j) The location of the main air line, air strainers, including auxiliary reservoirs, valves, branch connections and expansion joints, is shown on .... drawing, ...

(k) Connections to the branch air line must be made from the top of the main air line.

(l) An auxiliary reservoir having a capacity at least equal to total contents of the cylinder of the units operated therefrom must be connected in each branch line, the same to be provided with means for blowing off condensation.

(m) Each branch line must contain a combined brass cock and union at or near its connection with the main.

(n) The air line must be in good surface and auxiliary tanks connected in line at the bottom of slopes. The air line must be graded so condensation will run into the auxiliary tanks.

(o) The air line when placed above ground parallel to the track shall not be placed nearer than six (6) feet from the gauge side of nearest rail except by special permission.

(p) Local conditions shall determine the height of the air line when above ground; in general, when pipe line is run parallel to the tracks, bottom of the pipe shall be six (6) inches above top of ground.

(q) Stakes for supports shall be placed not more than ten (10) feet apart.

(r) Red lead, graphite or other equivalent protections for threads must be applied to the pipe threads and only after pipe connection has been started when pipe is coupled. The connections should be tested for leaks by applying the normal air pressure from time to time, as the pipe is being coupled.

(s) Each length of pipe and the fittings must be free from dirt and scale before being coupled in the line, and care must be exercised that no dirt gets into the line at any time. All pipe lines must be blown out before being connected to any apparatus.

FOUNDATIONS.

270. *Foundations.*

Field work.

(a) Foundations shall be rigid, level, and in perfect line.

(b) Foundations shall be set parallel to track, except as otherwise specified.

(c) Dimensions of concrete foundations shall be as follows:

	Top.	Base.	Depth.
Ground mast	26″x26″	36″x36″	48″
Ground mast with mechanism in base	30″x36″	42″x48″	48″
Bracket post	38″x38″	48″x48″	60″

(d) Concrete foundations shall stand until properly set before any apparatus is connected thereto or placed thereon.

(e) Foundations shall be so constructed that apparatus can be removed without disturbing them.

(f) Foundations shall conform to .... drawings ....

(g) The dimensions for concrete foundations are adaptable to level and solid ground. The Purchaser and Contractor shall jointly decide when deviations from specified sizes are necessary.

271. *Signal foundation bolts.*

(a) Foundation bolts for ground masts shall be one (1) inch by thirty-six (36) inches.

(b) Foundation bolts for bracket signal posts shall be one and one-half (1 1/2) inches by forty-eight (48) inches.

280. *Concrete.*

Concrete shall comply with Railway Signal Association specifications for "Concrete."

SIGNALS.

400. *Type and assembly.*

(a) Signals shall be of the semaphore type with arm travel .... (..) degrees in the ....

{ right* / left** } quadrant.

---

*Adopted by the Railway Signal Association.

**Recommended for Interurban lines.

400. *Type and assembly.*—Continued.

(b) The type of signals (as shown by the Railway Signal Association symbols) and location of signals shall be in accordance with .... drawing ....

(c) Signals and fittings shall conform to Railway Signal Association material specifications.

(d) The spacing of arms on all masts shall be in accordance with Railway Signal Association drawings 1035 or 1037.

401. *Ground signals.*

The general design, dimensions and structure shall be in accordance with Railway Signal Association drawing 1035.

402. *Bracket signals.*

(a) Bracket signal posts shall be made of .... (..) inch and .... (..) inch wrought iron pipe with water-tight joints, mounted in Railway Signal Association base, drawing 1036.

(b) Top of crosstrees shall be .... (..) feet .... (..) inches above base of bracket post.

403. *Bracket and bridge signals.*

Bracket and bridge signal masts shall be made of five (5) inch wrought iron pipe, mounted in Railway Signal Association base, drawing 1034.

410. *Semaphore spectacles.*

(a) High signal spectacles shall be in accordance with Railway Signal Association drawing $\left\{\begin{matrix}1040\\1041\end{matrix}\right\}$ with spectacle rings Railway Signal Association drawing 1042.

(b) Back lights $\left\{\begin{matrix}\text{shall}\\\text{shall not}\end{matrix}\right\}$ be furnished.

(c) Back light spectacle shall be designed for one (1) .... roundel.

415. *Signal blades.*

Signal blades shall be in accordance with Railway Signal Association drawing 1065, and shall be made of well seasoned white ash or ....

420. *Signal arm shafts.*

(a) Signal arm shafts shall be made of steel, not less than one and one-fourth (1 1/4) inches in diameter.

(b) Semaphore castings shall be mounted on square section of shaft. Operating arm shall be mounted on square section or otherwise securely fastened.

425. *Roundels.*

Roundels shall comply with Railway Signal Association specifications and shall be supplied as follows:

	Color.	Dia. inches.	
Stop	....	....	(..)
Caution	....	....	(..)
Proceed	....	....	(..)
Back light	....	....	(..)

430. *Lamps.*

(a) Lamps shall be $\left\{ \begin{array}{c} \text{oil} \\ \text{convertible} \end{array} \right\}$

(b) Oil lamps shall be in accordance with Railway Signal Association drawing 1100.

(c) Convertible lamps shall be equipped with .... (..) incandescent lamps and marine receptacles, in accordance with .... drawing ...., and with oil founts and burners.

(d) .... (..) extra incandescent lamps shall be furnished.

431. *Lamp boxes.*

Lamp boxes shall be in accordance with .... drawing ....

435. *Signal locations.*

(a) Signal masts shall be on the right of the track governed and adjacent thereto, where practicable.

(b) Signal arms on tangent shall be at right angles to track governed when sufficient approach is on tangent. On curves signal arms shall be at right angles to imaginary line drawn from the signal to the point where the best view can be obtained by the engineman, as decided by the Purchaser.

(c) Signals placed between tracks on tangent shall be set so that the center of mast shall be midway between tracks. Signals placed between tracks on curves shall be set off the center line between tracks and towards the center of the curve two and one-half (2 1/2) inches for each one (1) inch superelevation.

(d) Before any signals are erected, the Purchaser shall, in the presence of the Contractor's foreman (or other representative), locate each signal.

(e) Outside of tracks, ground masts shall be placed .... (..) feet and bracket posts .... (..) feet from nearest rail.

435. *Signal locations.*—Continued.

(f) Bridge masts shall be located on .... chord of bridge.

(g) Base of high signals shall be .... (..) inches below base of rail.

440. *Electric motor type.*

(a) Signals shall be of the electric motor type, low voltage holding device and low voltage alternating current $\left\{ \begin{matrix} \text{commutating} \\ \text{induction} \end{matrix} \right\}$ motor, operating mechanism located at ....

(b) Motor shall operate the semaphore arm from zero through an arc of .... (..) degrees in .... (..) seconds at .... (..) volts, and ... . (..) cycles, consuming not more than .... (..) volt-amperes, ... (..) watts.

(c) Starting and operating current at any point of the arc shall not exceed .... (..) amperes and .... (..) volt-amperes per phase.

(d) Motor shall operate the semaphore arm when there is an increase of fifty (50) per cent. foot pound torque, from zero through an arc of .... (..) degrees in .... (..) seconds, at .... (..) volts, and .... (..) cycles, consuming not more than .... (..) volt-amperes, ... (..) watts. Starting and operating current at any point of the arc shall not exceed .... (..) amperes and .... (..) volt-amperes per phase.

(e) Motor shall operate the semaphore arm from any point of the arc at a minimum of .... (..) volts, with normal frequency.

(f) Motor shall operate the semaphore arm when there is an increase of fifty (50) per cent. foot pound torque from any point of the arc at ten (10) per cent. under or over normal frequency, at normal voltage.

(g) Holding device shall consume not more than .... (..) volt-amperes, ... (..) watts, at .... (..) volts, ... (..) cycles. Shall be wound for .... (..) phase operation.

(h) Holding device shall be designed for continuous operation at ten (10) per cent. under or over normal frequency without excessive heating.

441. *Solenoid type.*

(a) Signal shall be of the solenoid type $\left\{\begin{array}{c}\text{high}\\ \text{low}\end{array}\right\}$ voltage holding device, operating mechanism located at ....

(b) Solenoid shall be wound for .... phase .... (..) cycle power. Solenoid shall operate the semaphore arm from zero through an arc of .... (..) degrees in .... (..) seconds at.... .... (..) volts, ... (..) cycles, consuming not more than .... (..) volt-amperes, ... (..) watts. Starting and operating current at any point of the arc shall not exceed .... (..) amperes and .... (..) volt-amperes per phase.

(c) Solenoid shall operate the semaphore arm when there is an increase of twenty-five (25) per cent. foot pound torque, from zero through an arc of .... (..) degrees in .... (..) seconds at .... (..) volts, with .... (..) cycles, consuming not more than .... (..) volt-amperes, ... (..) watts. Starting and operating current at any point of the arc shall not exceed .... (..) amperes and .... (..) volt-amperes per phase.

(d) Solenoid shall operate the semaphore arm from any point of the arc at a minimum of .... (..) volts, with normal frequency.

(e) Solenoid shall operate the semaphore arm when there is an increase of fifty (50) per cent. foot pound torque from any point of the arc at ten (10) per cent. under or over normal frequency at normal voltage without excessive heating.

(f) Holding device shall consume not more than .... (..) volt-amperes, ... (..) watts, at .... (..) volts, ... (..) cycles. Shall be wound for .... phase operation. Holding device shall be designed for continuous operation at ten (10) per cent. under or over normal frequency without excessive heating.

442. *Electro-pneumatic type.*

(a) Signals shall be of the electro-pneumatic type, operating mechanism located at ....

(b) Normal operation shall be at .... (..) lbs. pressure. Signal shall operate at minimum of .... (..) lbs. pressure, normal torque; .... (..) lbs. pressure when there is an increase of fifty (50) per cent. foot pound torque.

442. *Electro-pneumatic type.*—Continued.

(c) Control magnets shall consume not more than ... . (..) volt-amperes, ... (..) watts, total per signal, at .... (..) volts. To operate on a minimum of .... (..) volts. To operate normally on .... phase supply at .... (..) cycles. To be capable of continuous operation at ten (10) per cent. under or over normal frequency.

(d) Holding device shall consume not more than .... (..) volt-amperes, ... (..) watts, at .... (..) volts, ... (..) cycles. Shall be wound for .... phase operation.

(e) Holding device shall be designed for continuous operation at ten (10) per cent. under or over normal frequency without excessive heating.

(f) Cylinders and valves shall be of sufficient size and mechanism constructed to perform complete operation of a ninety (90) degree signal of Railway Signal Association standard in not more than four (4) seconds, with minimum air pressure of sixty (60) pounds per square inch.

443. *Light type signals.*

Signals shall be of the electric light type, displaying { two three } aspects. Aspects shall be given by lenses .... (..) inches in diameter, each lens shall be illuminated by { one two .... } electric lamps. Each lamp shall be incandescent of .... mean horizontal candlepower at .... (..) volts. Shall have a life of .... (..) hours at .... (..) volts. Shall consume .... (..) watts per candlepower at .... (..) volts.

CIRCUITS.

500. *Practice.*

Circuits shall comply with the Contractor's recommended practice unless otherwise specified.

501. *Switchboard circuits.*

Contractor's recommended arrangements of circuits shall be followed, subject to necessary modifications on account of special requirements.

502. *Track circuits.*

(a) Contractor shall provide .... track circuits as shown by the shaded tracks on Purchaser's drawing ...., dated .... The purpose of each track circuit will be indicated on the plan by one or more of the following letters:

A.—For control of annunciators.
B.—For control of automatic block signals.
C.—For control of highway crossing alarms.
D.—In place of or in addition to detector bars.
F.—For control of fouling point indicators.
R.—For control of route locks.
S.—For control of semiautomatic signals.

(b) Main track circuits shall be extended to the fouling point or derail on siding switches; on crossovers track circuits shall be extended so as to provide as much fouling protection as can be obtained.

(c) Non-interlocked main line single switches, both switches of crossovers and siding derails between home and distant signals shall be equipped with switch circuit controllers.

504. *Signal circuits.*

....
....
....

506. *Electric lighting circuits.*

(a) Electric lights on signals shall be arranged on ... . (..) circuits as follows:

....
....
....

(b) The maximum allowable drop in potential on electric lighting circuits from switchboard to any lamp shall be ten (10) per cent.

510. *Special circuits.*

The Purchaser will here indicate in full detail all special circuit requirements.

....
....
....

WIRE AND WIRING.

520. *Specification.*

(a) Wire and cable shall comply with the specifications of the Railway Signal Association.

(b) Cables built up at the site of the work and all flexible conductors shall have three sixty-fourths (3/64) inch wall of rubber.

521. *Size.*

(a) Wires shall be of sufficient size to permit operation of signal mechanism in accordance with previous specifications.

(b) Rubber covered wire smaller than number fourteen (14) B. & S. gauge shall not be used.

(c) Signal control wire shall be number fourteen (14) or .... (..) B. & S. gauge $\left\{\begin{array}{c}\text{solid}\\ \text{stranded}\end{array}\right\}$ $\left\{\begin{array}{c}\text{bare}\\ \text{insulated}\end{array}\right\}$ $\left\{\begin{array}{c}\text{copper}\\ \text{.......}\end{array}\right\}$ conductor.

(d) Main common wire shall be twelve (12) or.............. (..) B. & S. gauge and unless otherwise specified, shall be continuous without joints or breaks.

(e) In submarine cable work spare wires up to twenty-five (25) per cent. of the number in use shall be provided as specified. When spare wires are required in other than cable work the number and size shall be specified.

(f) Numbers and sizes of track circuit connections shall be as follows:

		No. of conductors.	B. & S. gauge.
1. Transformers to rail	one (1)	nine (9) or	......(...)
2. Relay to rail	one (1)	nine (9) or	......(...)
3. Fouling shunt connections	two (2)	nine (9) or	......(...)
4. Switch circuit controller connections	two (2)	nine (9) or	......(...)
5. Wire from trunking to track batteries in chutes, stranded	twelve (12)	or	...........(...)

(g) Wires connected to track shall be rubber-covered soft-drawn copper.

(h) Copper-clad steel wire shall not be smaller than number fourteen (14) B. & S. gauge.

(i) Number fourteen (14) or .... (..) B. & S. gauge wire shall be used for all connections from instrument to pole line or cable except for common.

521. *Size.*—Continued.

(j) Number fourteen (14) or .... (..) B. & S. gauge wire shall be used in main conduit for all wires except common.

(k) Number six (6) or .... (..) B. & S. gauge wire shall be used for connections of motor to transformer.

(l) Number fourteen (14) or .... (..) B. & S. gauge $\left\{\begin{matrix}\text{solid}\\ \text{stranded}\end{matrix}\right\}$ wire shall be used in connecting lightning arresters and junction terminals.

(m) Number .... (..) or .... (..) B. & S. gauge wire shall be used for all connections from instruments and motors to secondary distribution busses.

522. *Cables for low voltage circuits.*

(a) Aerial cables shall have .... (..) $\left\{\begin{matrix}\text{solid}\\ \text{stranded}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{copper}\\ \text{......}\end{matrix}\right\}$ conductors, No. .... (..) B. & S. gauge and .... (..) No. .... (..) B. & S. gauge $\left\{\begin{matrix}\text{solid}\\ \text{stranded}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{copper}\\ \text{......}\end{matrix}\right\}$ conductors.

(b) Underground signal cables shall have .... (..) $\left\{\begin{matrix}\text{solid}\\ \text{stranded}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{copper}\\ \text{......}\end{matrix}\right\}$ conductors No. .... (..) B. & S. gauge and .... (..) No. .... (..) B. & S. gauge $\left\{\begin{matrix}\text{solid}\\ \text{stranded}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{copper}\\ \text{......}\end{matrix}\right\}$ conductors.

(c) Submarine cables shall have .... (..) $\left\{\begin{matrix}\text{solid}\\ \text{stranded}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{copper}\\ \text{......}\end{matrix}\right\}$ conductors No. .... (..) B. & S. gauge and .... (..) No. .... (..) B. & S. gauge $\left\{\begin{matrix}\text{solid}\\ \text{stranded}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{copper}\\ \text{......}\end{matrix}\right\}$ conductors.

523. *Line wire for high voltage circuits.*

Signal transmission line shall be No. .... (..) B. & S. gauge $\left\{\begin{matrix}\text{solid}\\ \text{stranded}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{bare}\\ \text{insulated}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{copper}\\ \text{......}\end{matrix}\right\}$ conductor.

524. *Cables for high voltage circuits.*

(a) Aerial signal transmission cables shall have .... (..) $\left\{\begin{matrix}\text{solid}\\ \text{stranded}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{copper}\\ \text{......}\end{matrix}\right\}$ conductors No. .... (..) B. & S. gauge and ...... (..) No. .... (..)

524. *Cables for high voltage circuits.*—Continued.

B. & S. gauge $\left\{\begin{matrix}\text{solid}\\\text{stranded}\end{matrix}\right\}\left\{\begin{matrix}\text{copper}\\\text{......}\end{matrix}\right\}$ conductors.

(b) Underground signal transmission cables shall have ....(..) $\left\{\begin{matrix}\text{solid}\\\text{stranded}\end{matrix}\right\}\left\{\begin{matrix}\text{copper}\\\text{......}\end{matrix}\right\}$ conductors No. ...... (..) B. & S. gauge and ...... (..) No. ...... (..) B. & S. gauge $\left\{\begin{matrix}\text{solid}\\\text{stranded}\end{matrix}\right\}\left\{\begin{matrix}\text{copper}\\\text{......}\end{matrix}\right\}$ conductors.

(c) Submarine signal transmission cables shall have .... (..) $\left\{\begin{matrix}\text{solid}\\\text{stranded}\end{matrix}\right\}\left\{\begin{matrix}\text{copper}\\\text{......}\end{matrix}\right\}$ conductors No. .... (..) B. & S. gauge $\left\{\begin{matrix}\text{solid}\\\text{stranded}\end{matrix}\right\}\left\{\begin{matrix}\text{copper}\\\text{......}\end{matrix}\right\}$ conductors.

525. *Wiring.*

(a) Wires in trunking, chases or conduits shall be laid loosely without stretching or crowding.

(b) Not more than two (2) wires shall be connected to one (1) binding post or terminal screw.

526. *Common return.*

(a) Reductions in size of common wire and connections to pole lines shall be made in junction boxes.

(b) Connections between branches and main common wires shall be made in junction boxes.

527. *Joints in wire.*

(a) Wires shall, as far as practicable, be continuous without joints or breaks; joints shall be made only on permission from the Engineer.

(b) In making joints, braid shall be pulled back one (1) inch from end of rubber on each side of splice, and rubber cut with knife held at an angle of approximately thirty (30) degrees with axis of wire, as one would sharpen a pencil.

(c) After removing rubber, wire shall be thoroughly cleaned, care being taken to prevent injury from small cuts or nicks.

(d) Wire, after being cleaned, shall be twisted together in the form of a regular line wire splice, turns being spaced approximately one-sixty-fourth (1/64) inch.

(e) Joints shall then be soldered by pouring on them, or dipping them into, melted solder, a noncorrosive rosin flux being used. After soldering, joints shall be painted with .... insulating paint or with .... compound.

527. *Joints in wire.*—Continued.

(f) Joints shall then be covered with two (2) layers of .... insulating tape between ends of braid, which tape shall be heated sufficiently to form a tight covering, but not enough to injure the quality of the material. Coating of .... insulating paint or .... compound shall be put on over insulating tape and two (2) layers of .... adhesive or friction tape shall be applied, after which the outside of the joint shall be painted with .... insulating paint.

528. *Fuses.*

Material.

(a) Fuses shall be of the enclosed type.

Field work.

(b) The necessary fuses to properly protect all apparatus and circuits shall be installed.

(c) Fuses outside of buildings shall be enclosed in weatherproof boxes.

(d) In the lighting circuits, a fuse shall be provided in the circuit to each signal lamp; in the circuit to each set of lamps on a mast; in each branch circuit leaving the mains, and in each set of mains leaving the switchboard.

530. *Tags.*

Material.

(a) Tags shall be made of vulcanized sheet fibre, not less than one-sixteenth (1/16) inch thick, firmly attached to the wire by the best quality yacht marline one-sixteenth (1/16) inch in diameter.

(b) The tag shall have a stamped imprint to show the function of the wire.

Field work.

(c) Wires shall be tagged at all junction boxes, switches, signals, relay boxes, arrester boxes, and at all line wire connections, unless otherwise specified.

532. *Petroleum asphaltum.*

Material.

(a) Petroleum asphaltum shall comply with specifications of the Railway Signal Association for "Petroleum Asphaltum."

Field work.

(b) When specified, the wires in the trunking shall be loosely bound and shall be so laid in pitch as to be practically free of contact with all walls of the trunking.

(c) When petroleum asphaltum is used, terminal box bootlegs, trunking and bootleg terminals shall be in accordance with Railway Signal Association drawings 1154, 1155, 1156 and 1157.

BONDING.

540. *Bonding wires.*

Material.

(a) Bonding wires shall comply with Railway Signal Association specification for "Bonding Wires."

Field work.

(b) Number six (6) B. & S. gauge bare copper or copper-clad steel bonding wires shall be used.

(c) Bonding shall be in accordance with .... drawing .... Rail joints, except as below, shall be bonded with two (2) number six (6) B. & S. gauge bonding wires. Where joints are located in platforms or road crossings, whether of plank, brick, or ballast filling, four (4) wires must be used at each joint, two (2) being placed on either side of rail and outside of angle bar.

(d) Frogs shall be bonded in the same manner as the rail joints and shall be so connected, that the continuity of the track circuit will be broken when they are removed from the track.

542. *Channel pins.*

Material.

(a) Channel pins shall comply with the specifications of the Railway Signal Association for "Channel pins."

Field work.

(b) Each bond wire shall be fastened at each end into the web of the rail by a channel pin.

(c) Channel pins shall be driven the same day that holes are drilled.

CONTROL APPARATUS.

600. *Relays.*

Alternating current relays shall be in accordance with .... specifications.

601. *Line circuit relays.*

Line circuit relays shall consume not more than .... (..) volt-amperes .... (..) watts, per phase, at .... (..) volts .... (..) cycles. These will operate .... (..) phase, and be equipped with .... (..) fingers, ...(..) front and .... (..) back contacts. Front contacts shall carry .... (..) amperes continuously and break .... (..) amperes at .... (..) volts without excessive heating; back contacts shall carry .... (..) amperes continuously and break .... (..) amperes at .... (..) volts without excessive heating. These relays shall operate con-

601. *Line circuit relays.*—Continued.
tinuously without excessive heating at ten (10) per cent. under normal frequency.

602. *Track circuit relays.*

(a) Track circuit relays, receiving all of their energy over the track rails shall consume not more than .... (..) volt-amperes .... (..) watts, at .... (..) volts, ... (..) cycles. These will be equipped with .... (..) fingers, ... (..) front and .... (..) back contacts. Front contacts shall carry .... (..) amperes continuously and break .... (..) amperes at .... (..) volts without excessive heating; back contacts shall carry .... (..) amperes continuously and break .... (..) amperes at .... (..) volts without excessive heating. These relays shall operate continuously without excessive heating at ten (10) per cent. under normal frequency.

(b) Track circuit relays receiving a part of their energy from the track rails and part from another source, shall consume not more than .... (..) volt-amperes .... (..) watts at .... (..) volts, ... (..) cycles, from the track, with not more than .... (..) volt-amperes .... (..) watts, at .... (..) volts, ... (..) cycles being taken from the other source. These shall be equipped with .... (..) fingers .... (..) front and .... (..) back contacts. Front contacts shall carry .... (..) amperes continuously and break .... (..) amperes at .... (..) volts without excessive heating; back contacts shall carry .... (..) amperes continuously and break .... (..) amperes at .... (..) volts without excessive heating. These relays shall pick up on a minimum of .... (..) volts .... (..) amperes at .... (..) cycles, from the track, with energy received from the other source being supplied at .... (..) volts .... (..) cycles; and the currents in the two elements at $\left\{\begin{array}{l}\text{galvanometer } 0^\circ \text{ or } 180^\circ\\ \quad\text{induction } 90^\circ \text{ or } 270^\circ\end{array}\right\}$ phase displacement. The energy taken from the other source shall be not more than .... (..) volt-amperes, ... (..) watts, at .... (..) volts, ... (..) cycles. This current shall not exceed .... (..) amperes when the track coil is short circuited, at............(..)

602. *Track circuit relays.*—Continued.

volts .... (..) cycles. Impedance coil, when used in series with feed from other source, shall consume not more than .... (..) volt-amperes, ... (..) watts, at .... (..) volts, ... (..) cycles. These relays shall operate continuously without excessive heating at ten (10) per cent. under normal frequency.

610. *Circuit controllers.*

Material.

(a) Circuit controllers of substantial construction and positive in action shall be provided for track switches as specified and shall be so constructed that they can be maintained to make or break circuit when switch point shall be moved from the closed position three-sixteenths (3/16) of an inch.

(b) Operating rods of switch circuit controllers shall be not less than five-eighths (5/8) inch in diameter and adjustable, with a maximum distance of three (3) feet between supports.

(c) Circuit controllers for non-interlocked switches shall have two independent shunt connections to the track circuit of each track affected by the opening of the switch.

(d) Lever and latch circuit controllers shall have .... (..) fingers .... (..) normally open and .... (..) closed contacts.

(e) Circuit controllers for switch points, movable point frogs or derails shall have .... (..) fingers with .... (..) normally open and .... (..) closed contacts.

(f) Drawbridge circuit controllers shall have .... (..) fingers with .... (..) normally open and .... (..) closed contacts.

(g) Circuit controllers for mechanically interlocked signals shall have .... (..) fingers with .... (..) open and .... (..) closed contacts.

(h) Current carrying parts shall be capable of breaking .... (..) amperes at .... (..) volts.

Field work.

(i) The switch circuit controller shall be positively connected to one or both points; if but one point, the normally .... shall be selected.

(j) The switch circuit controller shall be insulated from the tie plate and from the track.

615. *Electric locks for hand-operated track switches.*

(a) Electric locks shall be in accordance with .... specifications.

(b) Electric locks shall consume not more than....... .... (..) volt-amperes .... (..) watts at .... (..) volts, ... (..) phase, ... (..) cycles, and shall have .... (..) fingers with .... (..) normally open and .... (..) normally closed contacts. All contacts shall carry .... (..) amperes continuously and break .... (..) amperes at .... (..) volts, without excessive heating.

618. *Hand releases.*

....
....
....

622. *Time locks.*

....
....
....

625. *Switch indicators.*

(a) Switch indicators shall be in accordance with .... specifications.

(b) Switch indicators shall consume not more than ... . (..) volt-amperes .... (..) watts, at .... (..) volts, ... (..) cycles, per phase; wound to operate on .... phase supply.

(c) To be equipped with .... (..) fingers, ... (..) front and .... (..) back contacts. Front contacts shall carry .... (..) amperes continuously and break .... (..) amperes at .... (..) volts without excessive heating. Back contacts shall carry .... (..) amperes continuously and break .... (..) amperes at .... (..) volts.

635. *Lightning arresters.*

(a) Lightning arresters of .... design shall be used at all aerial line connections.

(b) Lightning arresters for high tension line shall be in accordance with .... specifications.

TRUNKING CONDUITS AND SUPPORTS.

700. *Trunking.*

Material.

(a) Grooved trunking, built up trunking and all capping shall be .... lumber and comply with the Railway Signal Association specification for "Wood trunking."

700. *Trunking.*—Continued.

(b) The dimensions for trunking shall comply with Railway Signal Association drawings 1176 or 1177.

(c) Treated trunking shall be used when specified, and shall comply with the attached requirements as to treatment.

Field work.

(d) The location of the main runs of trunking is shown on .... drawing ....

(e) Permission shall be obtained to place between tracks runs of trunking parallel with the tracks.

(f) Trunking, when on stakes above ground and running parallel with the track, shall not be placed nearer than six (6) feet from the gauge side of the nearest rail except by special permission.

(g) Local conditions shall determine the height of trunking when above ground; in general, when trunking is run parallel with the tracks, bottom of trunking shall be placed approximately six (6) inches above ground.

(h) Drainage of the trunking shall be provided as follows:

....

....

....

(i) Nails shall not be driven through the trunking from the inside of the groove nor shall they be driven into the groove from the outside.

(j) Inside corner of trunking, at turns, must be rounded to prevent insulation on wires being injured.

(k) Surfaces of trunking that are to be painted shall be finished.

(l) Not less than one-third (1/3) of the capacity of the groove shall remain free for the further installation of wires.

(m) As specified, capping shall be securely fastened to trunking with $\left\{\begin{array}{c}\text{gate hooks.}\\ \text{nails.}\end{array}\right\}$ Gate hooks may be used on main runs of trunking and nails on cross leads.

703. *Joints in trunking.*

(a) Unless otherwise specified, joints in grooved trunking shall be lapped, the ends of trunking being beveled at an angle of forty-five (45) degrees.

(b) Joints in built up trunking shall be staggered.

(c) Joints in capping shall be made at least one (1) foot from joints in trunking.

705. *Trunking supports.*

Material.

(a) Stakes shall be made of .... three (3) inches by four (4) inches, or of equivalent circular section and of sufficient length to allow them to be placed at least two (2) feet in the ground. When, due to local requirements, stakes of a greater length than three (3) feet six (6) inches, or a greater cross section than three (3) inches by four (4) inches will be necessary, information as to the number, length and cross section will be furnished by the Purchaser to the Contractor.

Field work.

(b) Trunking above ground shall be supported on stakes placed not more than five (5) feet centers.

(c) When trunking exceeds a width of seven (7) inches a special arrangement consisting of

{ a double line of stakes
{ a single line of large stakes } shall be installed, or provision shall be made as follows:......................

....

....

(d) Stakes supporting trunking shall be placed vertically and extend at least two (2) feet below the surface of the ground, unless otherwise specified.

(e) A piece of capping eight (8) inches long and the width of the trunking shall be placed between the trunking and each stake.

(f) Each joint in the bottom of the trunking shall be supported by a stake.

708. *Bootlegs.*

Bootlegs for track connection shall be made in accordance with .... drawing .... They shall be securely fastened to the trunking, not less than two (2) inches from base of rail, and shall not extend more than one (1) inch above base of rail.

710. *Junction boxes.*

Material.

(a) Junction boxes shall be made of .... and so designed that terminals will be kept dry. Each junction box shall be fitted with a cover, hasp and staple.

(b) Where ten (10) or less wires are used, junction boxes shall be sixteen (16) inches square by twenty (20) inches deep, inside dimensions, and shall be increased six (6) inches in length for each ten (10) additional connections or fraction thereof made in the box.

710. *Junction boxes.*—Continued.
Field work.

(c) Junction boxes shall be located as shown on .... drawing .... and at a height sufficient to allow terminals to be placed at least six (6) inches above top of trunking.

(d) Junction boxes shall be supported in the same manner as the trunking.

711. *Conduits.*

(a) Fibre conduits shall comply with Railway Signal Association's specifications for "Fibre Conduits."

(b) Vitrified clay conduits shall comply with Railway Signal Association's specifications for "Vitrified Clay Conduits."

LINE CONSTRUCTION.

714. *Line construction.*

Line construction shall comply with local laws.

715. *Supports for line.*

(a) Line wire shall be supported by cross arms, pins and insulators.

(b) Cross-arms shall be in accordance with Railway Signal Association's specifications for "Cross-arms."

(c) Cross-arm pins, braces, lags, through bolts, double arming bolts, and insulators shall be in accordance with Railway Signal Association's specifications for "Cross-arm pins and bolts."

(d) Special bracket and insulators shall be in accordance with .... drawing ....

(e) Aerial cable shall be supported by messenger wire. Messenger wire shall be supported by L clamps which will be furnished in place by ....

(f) Cable shall be supported on messenger wire by hooks and marlin loops or by ....

(g) Line wire supports shall be furnished in place by ....

717. *Supports for high voltage cable.*

(a) Messenger wire shall be .... (..) inches in diameter and in accordance with .... specifications.

(b) Messenger wire fixtures shall be in accordance with .... drawing ....

718. *Cable boxes.*

(a) Cables shall terminate in cable boxes in accordance with .... drawing ....

(b) Cable boxes shall be furnished in place by ....

INSTRUMENT SHELTER.

720. *Relay boxes.*

Material.

(a) Relay boxes at signals and track circuit limits shall be in accordance with .... drawing ...., and shall be made of $\left\{\begin{array}{c}\text{wood}\\ \text{wood lined}\\ \text{cast iron}\end{array}\right\}$

Field work.

(b) Terminals for relay boxes at signal locations shall be arranged in accordance with .... drawing ....

(c) Terminals in boxes at track circuit limits shall be arranged in accordance with .... drawing ....

721. *Relay cases.*

Relay cases for interlocking stations shall be in accordance with .... drawing .... and shall be neatly finished and dustproof.

722. *Lightning arrester boxes.*

Boxes for housing lightning arresters shall be in accordance with .... drawing ....

723. *Transformer shelters.*

....
....
....

724. *Grid or unit resistance shelters.*

....
....
....

INSULATIONS.

735. *Insulated rail joints.*

Material.

(a) Insulated rail joints shall be in accordance with .... drawing ....

Field work.

(b) Both rails shall be insulated at fouling points, ends of track circuits and in switch leads.

(c) Rail joints shall be installed by the Purchaser at joints designated by the ....

738. *Switch rod insulations.*

Material.

(a) Switch rod insulations shall be in accordance with .... drawing ....

Field work.

(b) Insulations for switch rods shall be installed by the Purchaser at points designated by the ....

738. *Switch rod insulations.*—Continued.

(c) Switches to be insulated are equipped with .... (..) switch rods, ... (..) inches by .... (..) inches cross section, as shown on .... drawing .... except as noted on .... drawing ...., dated ....

742. *Pipe line insulation.*

Material.

(a) Pipe line insulation shall be in accordance with Railway Signal Association drawing 1094.

Field work.

(b) Pipe line insulations shall be installed by the ....

744. *Tie plate insulations.*

Material.

(a) Tie plate insulations shall be in accordance with.. .... drawing ....

Field work.

(b) Insulated tie plates shall be installed by the ....

748. *Insulating fibre.*

Insulating fibre shall comply with Railway Signal Association specifications for "Hard fibre."

PAINTING.

800. *Paint.*

Material.

(a) Purchaser will indicate here the kind of paint that shall be required:

....

....

....

Field work.

(b) Surfaces covered with rust, grease, dirt or other foreign substances, shall be thoroughly cleaned before paint or oil is applied.

(c) Paint shall not be applied to outside surfaces in freezing weather, nor to wet surfaces, nor until previous coating has thoroughly dried.

(d) Finishing coats shall not be applied until after the expiration of forty-eight (48) hours after the previous coating has been applied.

(e) Paints mixed on the ground shall be applied within three (3) hours after the pigment and oil are mixed.

800. *Paint.*—Continued.

(f) Priming coats shall be applied as soon as is consistent with the progress of the work.

(g) Second coat shall be applied in sufficient time for the third coat to be applied and dry when the installation is completed.

810. *Iron work.*

(a) Iron work (except tie plates and air pipe line) not galvanized shall be painted one (1) coat of red lead and raw linseed oil and two (2) finishing coats.

(b) The following specific finishing coats shall be used:

	Kind of paint.	Color.
Signal bridges and brackets	....	....
Signal masts	....	....

830. *Wood work.*

Exposed wood work shall be given one (1) priming coat and finishing coats as follows:

	Kind of paint.	Color.	Number of coats.
Home signal blades	....	....	......(..)
Distant signal blades	....	....	......(..)
Trunking, junction boxes, etc.	....	....	......(..)

840. *Buildings.*

Power house or other buildings constructed of wood shall receive one (1) priming coat and two (2) finishing coats. The priming coat shall consist of .... and when thoroughly dry two (2) coats of .... in the following tints, shall be applied:

....

....

....

SPECIAL ITEMS.

900.

....

....

....

925. *Locks.*

Purchaser's standard locks shall be used when specified.

926. *Number plates and numbers.*

(a) *Number plates.*

. . . .

. . . .

. . . .

(b) *Numbers.*

. . . .

. . . .

. . . .

928. *Junction terminals.*

Junction terminals shall be in accordance with Railway Signal Association drawing 1055.

501. *Switchboard circuits.*

Contractor's recommended arrangement of circuits shall be followed, subject to necessary modifications on account of special requirements.

502. *Track circuits.*

(a) Contractor shall provide .... track circuits as shown by the shaded tracks on Purchaser's drawing ...., dated .... The purpose of each track circuit will be indicated on the plan by one or more of the following letters:

A.—For control of annunciators.
B.—For control of automatic block signals.
C.—For control of highway crossing alarms.
D.—In place of or in addition to detector bars.
F.—For control of fouling point indicators.
R.—For control of route locks.
S.—For control of semiautomatic signals.

(b) Main track circuits shall be extended to the fouling point or derail on siding switches; on crossovers track circuits shall be extended so as to provide as much fouling protection as can be obtained.

(c) Non-interlocked single main line switches, both ends of crossover switches and siding derails shall be equipped with switch circuit controllers.

504. *Signal circuits.*

....
....
....

506. *Electric lighting circuits.*

(a) Electric lights on signals shall be arranged on ... . (..) circuits as follows:

....
....
....

(b) The maximum allowable drop in potential on electric lighting circuits from switchboard to any lamp shall be ten (10) per cent.

510. *Special circuits.*

The Purchaser will here indicate in full detail all special circuit requirements.

....
....
....

WIRE AND WIRING.

520. *Specification.*

(a) Wire and cable shall comply with the specifications of the Railway Signal Association.

(b) Cables built up at the site of the work and all flexible conductors, except for battery chutes, shall have three sixty-fourths (3/64) inch wall of rubber. 1912.

521. *Size.*

(a) Wires shall be of sufficient size to permit operation of signal mechanism in accordance with previous specifications.

(b) Rubber covered wire smaller than number fourteen (14) B. & S. gauge shall not be used.

(c) Signal control wire shall be number fourteen (14) or .... (...) B. & S. gauge $\left\{\begin{matrix}\text{solid}\\ \text{stranded}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{bare}\\ \text{insulated}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{copper}\\ \text{........}\end{matrix}\right\}$ conductor. 1912.

(d) Main common return wire shall be number twelve (12) or .... (...) B. & S. gauge. 1912.

(e) In submarine cable work spare wires up to twenty-five (25) per cent. of the number in use shall be provided as specified. When spare wires are required in other than cable work the number and size shall be specified.

(f) Numbers and sizes of track circuit connections shall be as follows:

	No. of conductors.	B. & S. gauge.
1. Track batteries to rail	one (1)	nine (9) or ...... (..).
2. Relay to rail	one (1)	nine (9) or ...... (..).
3. Fouling shunt connections	two (2)	nine (9) or ...... (..).
4. Switch circuit controller connections	two (2)	nine (9) or ...... (..).
5. Wire from trunking to track batteries in chutes, stranded		twelve (12) or.... (..).

1912.

(g) Wires connected to track shall be rubber-covered soft-drawn copper.

(h) Copper-clad steel wire shall not be smaller than number fourteen (14) B. & S. gauge.

(i) Number fourteen (14) or .... (...) B. & S. gauge wire shall be used for all connections from instrument to pole line or cable except for common. 1912.

521. *Size.*—Continued.

(j) Number fourteen (14) or .... (...) B. & S. gauge wire shall be used in main conduit for all wires except common. 1912.

(k) Number six (6) or .... (...) B. & S. gauge wire shall be used for connections of motor to battery. 1912.

(l) Number fourteen (14) or .... (...) B. & S. gauge $\left\{\begin{matrix}\text{solid}\\ \text{stranded}\end{matrix}\right\}$ wire shall be used in connecting lightning arresters and junction terminals. 1912.

522. *Cables for low voltage circuits.*

(a) Aerial cables shall have .... (..) $\left\{\begin{matrix}\text{solid}\\ \text{stranded}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{copper}\\ \text{......}\end{matrix}\right\}$ conductors, No. .... (..) B. & S. gauge and .... (..) No. .... (..) B. & S. gauge $\left\{\begin{matrix}\text{solid}\\ \text{stranded}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{copper}\\ \text{......}\end{matrix}\right\}$ conductors.

(b) Underground signal cables shall have .... (..) $\left\{\begin{matrix}\text{solid}\\ \text{stranded}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{copper}\\ \text{......}\end{matrix}\right\}$ conductors No. .... (..) B. & S. gauge and .... (..) No. .... (..) B. & S. gauge $\left\{\begin{matrix}\text{solid}\\ \text{stranded}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{copper}\\ \text{......}\end{matrix}\right\}$ conductors.

(c) Submarine cables shall have .... (..) $\left\{\begin{matrix}\text{solid}\\ \text{stranded}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{copper}\\ \text{......}\end{matrix}\right\}$ conductors No. .... (..) B. & S. gauge and .... (..) No. .... (..) B. & S. gauge $\left\{\begin{matrix}\text{solid}\\ \text{stranded}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{copper}\\ \text{......}\end{matrix}\right\}$ conductors.

525. *Wiring.*

(a) Wires in trunking, chases or conduits shall be laid loosely without stretching or crowding.

(b) Not more than two (2) wires shall be connected to one (1) binding post or terminal screw.

(c) Unless otherwise specified, all wires shall be run as separate conductors.

526. *Common return.*

(a) Reductions in size of common wire and connections to pole lines shall be made in junction boxes.

(b) Connections between branches and main common wires shall be made in junction boxes.

(c) Unless otherwise specified, main common return wires shall be continuous without joints or breaks.

527. *Joints in wire.*

(a) Wires shall, as far as practicable, be continuous without joints or breaks; joints shall be made only on permission from the Engineer.

(b) In making joints, braid shall be pulled back one (1) inch from end of rubber on each side of splice, and rubber cut with knife held at an angle of approximately thirty (30) degrees with axis of wire, as one would sharpen a pencil.

(c) After removing rubber, wire shall be thoroughly cleaned, care being taken to prevent injury from small cuts or nicks.

(d) Wire, after being cleaned, shall be twisted together in the form of a regular line wire splice, turns being spaced approximately one-sixty-fourth (1/64) inch.

(e) Joints shall then be soldered by pouring on them, or dipping them into, melted solder, a noncorrosive rosin flux being used. After soldering, joints shall be painted with .... insulating paint or with .... compound.

(f) Joints shall then be covered with two (2) layers of .... insulating tape between ends of braid, which tape shall be heated sufficiently to form a tight covering, but not enough to injure the quality of the material. Coating of .... insulating paint or .... compound shall be put on over insulating tape and two (2) layers of .... adhesive or friction tape shall be applied, after which the outside of the joint is to be painted with .... insulating paint.

528. *Fuses.*

Material.

(a) Fuses shall be of the enclosed type.

Field work.

(b) The necessary fuses to properly protect all apparatus and circuits shall be installed.

(c) Fuses outside of buildings shall be enclosed in weatherproof boxes.

(d) In the lighting circuits, a fuse shall be provided in the circuit to each signal lamp; in the circuit to each set of lamps on a mast; in each branch circuit leaving the mains, and in each set of mains leaving the switchboard.

705. *Trunking supports.*—Continued.

(e) A piece of capping eight (8) inches long and the width of the trunking shall be placed between the trunking and each stake.

(f) Each joint in the bottom of the trunking shall be supported by a stake.

708. *Bootlegs.*

Bootlegs for track connection shall be made in accordance with .... drawing .... They shall be securely fastened to the trunking, not less than two (2) inches from base of rail, and shall not extend more than one (1) inch above base of rail.

710. *Junction boxes.*

Material.

(a) Junction boxes shall be made of .... and so designed that terminals will be kept dry. Each junction box shall be fitted with a cover, hasp and staple.

(b) Where ten (10) or less wires are used, junction boxes shall be sixteen (16) inches square by twenty (20) inches deep, inside dimensions, and shall be increased six (6) inches in length for each ten (10) additional connections or fraction thereof made in the box.

Field work.

(c) Junction boxes shall be located as shown on .... drawing .... and at a height sufficient to allow terminals to be placed at least six (6) inches above top of trunking.

(d) Junction boxes shall be supported in the same manner as the trunking.

711. *Conduits.*

(a) Fibre conduits shall comply with Railway Signal Association's specifications for "Fibre conduits."

(b) Vitrified clay conduits shall comply with Railway Signal Association's specifications for "Vitrified clay conduits." 1912.

714. *Line construction.*

Line construction shall comply with local laws.

1912.

715. *Supports for line.*

(a) Line wire shall be supported by cross arms, pins and insulators.

(b) Cross-arms shall be in accordance with Railway Signal Association specifications for "Cross-arms."

1912.

715. *Supports for line.*—Continued.

(c) Cross-arm pins, braces, lags, through bolts, and double arming bolts shall be in accordance with Railway Signal Association's specifications for "Cross-arm pins, bolts, etc." 1912.

(d) Special bracket and insulators shall be in accordance with .... drawing ....

(e) Aerial cable shall be supported by messenger wire. Messenger wire shall be supported by L clamps which will be furnished in place by ....

(f) Cable shall be supported on messenger wire by hooks and marlin loops or by ....

(g) Line wire supports shall be furnished in place by ....

718. *Cable boxes.*

(a) Cables shall terminate in cable boxes in accordance with .... drawing ....

(b) Cable boxes shall be furnished in place by ....

INSTRUMENT AND BATTERY SHELTERS.

720. *Relay boxes.*

Material.

(a) Relay boxes at signals and track circuit limits shall be in accordance with ....drawing ...., and shall be made of
{ wood.
wood lined.
cast iron. }

Field work.

(b) Terminals in relay boxes at signal locations shall be arranged in accordance with .... drawing ....

(c) Terminals in boxes at track circuit limits shall be arranged in accordance with .... drawing ....

721. *Relay cases.*

Relay cases for interlocking stations shall be in accordance with .... drawing .... and shall be neatly finished and dustproof.

722. *Lightning arrester boxes.*

Boxes for housing lightning arresters shall be in accordance with .... drawing ....

725. *Battery chutes.*

(a) Battery chutes shall be of cast iron
{ 6
7
8
9 } feet

725. *Battery chutes.*—Continued.

long, in accordance with Railway Signal Association drawing $\left\{\begin{matrix}1228.\\1229.\end{matrix}\right\}$

(b) Cast iron battery chutes shall be uniform in thickness, water-tight, and the inside surface shall be smooth to provide not less than three-eighths (3/8) inch clearance for elevator on all sides.

(c) Cast iron or .... covers shall be provided for each battery chute in accordance with .... drawing ....

(d) Elevators for battery chutes shall be in accordance with Railway Signal Association drawing 1227.

728. *Battery wells.*

(a) Battery wells shall be in accordance with .... drawing ....

(b) Concrete battery wells shall be .... (..) feet in diameter, ... (..) feet high, inside dimensions, and shall be water-tight.

(c) Frost neck .... (..) feet in diameter .... (..) feet in height shall be furnished for each well.

(d) Durable wood covers protected by number eighteen (18) galvanized iron shall be provided. The covers shall be in accordance with .... drawing .... The covers shall be fastened with properly arranged chain or iron strap and provision made for locking.

(e) Shelving shall be arranged in the well in accordance with .... drawing ....

INSULATIONS.

735. *Insulated rail joints.*

Material.

(a) Insulated rail joints shall be in accordance with .... drawing ....

Field work.

(b) Both rails shall be insulated at fouling points, ends of track circuits and in switch leads.

(c) Rail joints shall be installed by the Purchaser at joints designated by the Contractor.

738. *Switch rod insulations.*

Material.

(a) Switch rod insulations shall be in accordance with .... drawing ....

Field work.

(b) Insulations for switch rods shall be installed by the Purchaser at points designated by the ....

(c) Switches to be insulated are equipped with .... (..) switch rods, ... (..) inches by .... (..) inches cross section, as shown on .... drawing .... except as noted on .... drawing .... dated ....

742. *Pipe line insulation.*

Material.

(a) Pipe line insulation shall be in accordance with Railway Signal Association drawing 1094.

Field work.

(b) Pipe line insulations shall be installed by the ....

744. *Tie plate insulations.*

Material.

(a) Tie plate insulations shall be in accordance with.. .... drawing ....

Field work.

(b) Insulated tie plates shall be installed by the ....

748. *Insulating fibre.*

Insulating fibre shall comply with Railway Signal Association specifications for "Hard fibre."

PAINTING.

800. *Paint.*

Material.

(a) Purchaser will indicate here the kind of paint that shall be required:

....
....
....

Field work.

(b) Surfaces covered with rust, grease, dirt or other foreign substances, shall be thoroughly cleaned before paint or oil is applied.

800. *Paint.*—Continued.

(c) Paint shall not be applied to outside surfaces in freezing weather, nor to wet surfaces, nor until previous coating has thoroughly dried.

(d) Finishing coats shall not be applied until after the expiration of forty-eight (48) hours after the previous coating has been applied.

(e) Paints mixed on the ground shall be applied within three (3) hours after the pigment and oil are mixed.

(f) Priming coats shall be applied as soon as is consistent with the progress of the work.

(g) Second coat shall be applied in sufficient time for the third coat to be applied and dry when the installation is completed.

810. *Iron work.*

(a) Iron work not galvanized shall be painted one (1) coat of red lead and raw linseed oil and two (2) finishing coats.

(b) The following specific finishing coats shall be used:

	Kind of paint.	Color.
Signal bridges and brackets	....	....
Signal masts	....	....
All connections	....	....

830. *Wood work.*

Exposed wood work shall be given one (1) priming coat and finishing coats as follows:

	Kind of paint.	Color.	Number of coats.
Home signal blades	....	....	......(..)
Distant signal blades	....	....	......(..)
Trunking, junction boxes, etc.	....	....	......(..)

840. *Buildings.*

Buildings, if constructed of wood, shall receive one (1) priming coat and two (2) finishing coats. The priming coat shall consist of .... and, when thoroughly dry, two (2) coats of .... in following tints, shall be applied:

....

....

....

SPECIAL ITEMS.

900.

....

....

....

925. *Locks.*

Purchaser's standard locks shall be used where specified.

926. *Number plates and numbers.*

(a) Number plates.

....

....

....

(b) Numbers.

....

....

....

928. *Junction terminals.*

Junction terminals shall be in accordance with Railway Signal Association drawing 1056.

CAUSTIC SODA PRIMARY CELL—Specifications.
Drawing 1053—Signal Cell.

GRAVITY BATTERY ZINC—Specifications.
Drawing 1087.

GRAVITY BATTERY COPPER—Specifications.
Drawing 1088.

STORAGE, ELECTROLYTE, NEW—Tests for.

STORAGE, STATIONARY LEAD TYPE—Description of.

STORAGE, STATIONARY LEAD TYPE—Instructions for Operation.

STORAGE, STATIONARY LEAD TYPE—Instructions for Operation—Interlockings.

STORAGE, LEAD TYPE—Instructions for Operation—Block Signal Service.

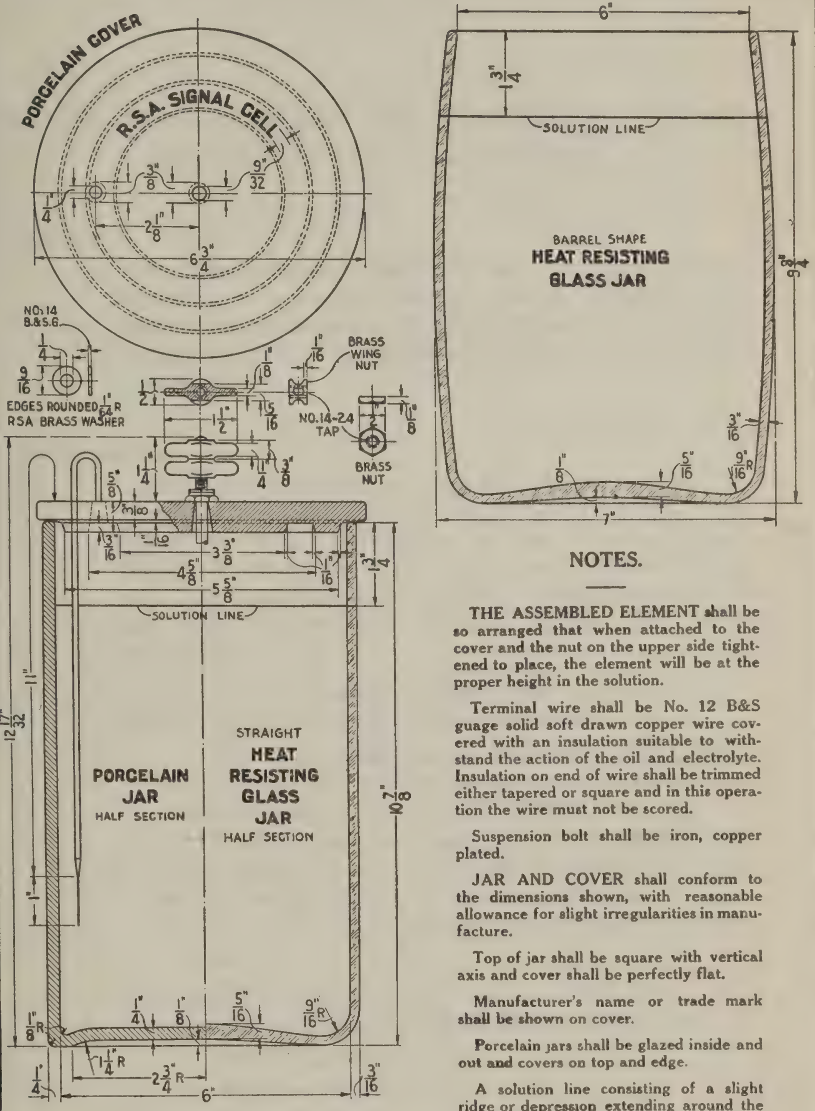
STORAGE, PORTABLE LEAD TYPE—Directions for Installation.

STORAGE, PORTABLE LEAD TYPE—Instructions for Operation.

STORAGE, PORTABLE LEAD TYPE—Specifications.

STORAGE, STATIONARY—Specifications for Interlockings.
Drawing 1174—Charging Panel.
Drawing 1224—Lead Type Storage Battery.

STORAGE, STATIONARY LEAD TYPE—Directions for Installation.


PORCELAIN COVER
R.S.A. SIGNAL CELL
3"/8
9"/32
1/4
2 1"/8
6 3"/4
NO.14 B.&S.G.
1/4
9/16
EDGES ROUNDED 1"/64 R
RSA BRASS WASHER
1"/16
BRASS WING NUT
1"/8
1/2
1 5/16
1 1"/2
NO.14-24 TAP
1"/8
BRASS NUT
1 1"/4
5"/8
3/100
1"/4
3"/8
3"/16
1/16
3 3"/8
4 5"/8
5 5"/8
1"/16
1 3"/4
SOLUTION LINE
11"
12 17"/32
PORCELAIN JAR
HALF SECTION
STRAIGHT HEAT RESISTING GLASS JAR
HALF SECTION
10 7"/8
1"
1"/8 R
1"/4
1"/8
5"/16
9"/16 R
1 1"/4 R
2 3"/4 R
1"/4
6"
3"/16
6"
3"/4
SOLUTION LINE
BARREL SHAPE HEAT RESISTING GLASS JAR
9 3"/4
3"/16
1"/8
5"/16
9"/16 R
7"

NOTES.

THE ASSEMBLED ELEMENT shall be so arranged that when attached to the cover and the nut on the upper side tightened to place, the element will be at the proper height in the solution.

Terminal wire shall be No. 12 B&S guage solid soft drawn copper wire covered with an insulation suitable to withstand the action of the oil and electrolyte. Insulation on end of wire shall be trimmed either tapered or square and in this operation the wire must not be scored.

Suspension bolt shall be iron, copper plated.

JAR AND COVER shall conform to the dimensions shown, with reasonable allowance for slight irregularities in manufacture.

Top of jar shall be square with vertical axis and cover shall be perfectly flat.

Manufacturer's name or trade mark shall be shown on cover.

Porcelain jars shall be glazed inside and out and covers on top and edge.

A solution line consisting of a slight ridge or depression extending around the inside of porcelain jars and the outside of glass jars shall be placed as shown.

R. S. A. SIGNAL CELL
CAUSTIC SODA PRIMARY BATTERY

**RSA
1053**

OCT.12

Battery.
Storage.
Lead Type
Stationary.
Specifications.

SPECIFICATIONS FOR LEAD TYPE STATIONARY STORAGE BATTERY FOR INTERLOCKINGS.

1912.

1. *Purpose.*

The intent of these specifications is to provide for the furnishing of complete storage battery cells and parts, designed to be located in interlocking stations or battery houses and used for operating interlocking and signal apparatus.

2. *Designations.*

(a) In ordering cells or parts the nominal capacity required will be designated as "40 A.H.," "80 A.H.," "120 A.H.," "200 A.H.," "320 A.H.," or "400 A.H.," and these terms shall be understood to signify, on an eight (8) hour basis, the capacities and dimensions thus designated in these specifications and Railway Signal Association drawing 1224.

(b) Each complete cell, unless otherwise specified, is understood to include the following parts:

1. One (1) positive group, consisting of the necessary number of positive plates assembled with connecting strap and one (1) connecting bolt.
2. One (1) negative group, consisting of the necessary number of negative plates assembled with connecting strap and one (1) connecting bolt.
3. One (1) set of separators, with dowels and hold downs.
4. One (1) glass jar.
5. One (1) glass sand tray, with moulded feet.
6. One (1) glass cell cover.
7. Required electrolyte.

(c) Positive or negative groups, if ordered separately, will be ready for service after an initial charge continued for fifty (50) to sixty (60) hours at the eight (8) hour rate.

3. *Capacity of battery.*

In conformity with service requirements.

4. *Number of cells per battery.*

In conformity with voltage requirements.

5. *Dimensions.*

Jars, sand trays and covers must conform to Railway Signal Association drawing 1224, which is an essential part of these specifications.

6. *Elements.*

(a) Positive plates shall be of the Plante type.

(b) Negative plates shall be either of the Plante type or of the type having mechanically applied active material.

(c) Positive and negative plates shall be respectively connected into positive and negative groups by burning to lead straps.

7. *Separators.*

Separators shall be of specially treated wood.

8. *Electrolyte.*

(a) Electrolyte shall have a specific gravity of between 1.205 and 1.215 at the end of the initial charge in service.

(b) Electrolyte shall be in accordance with Railway Signal Association specifications.

9. *Acceptance.*

No unit or part will be accepted which does not, in the judgment of the Purchaser, conform to the best practice with respect to material and workmanship.

10. *Service requirements.*

(a) It is essential that all parts shall be rugged in the highest degree both mechanically and electrically. The apparatus furnished must give satisfactory and economical service.

(b) Should any injurious buckling of plates occur in normal service within one (1) year after delivery, or should the capacity of any cell or element fall to less than eighty-five (85) per cent. of the specified capacity at the eight (8) A. H. rate, in normal service, within

10. *Service requirements.*—Continued.

one (1) year after delivery, the Contractor must replace the defective parts and restore the affected cells to their full specified capacity and to a condition satisfactory to the Purchaser, without additional cost to him.

(c) As far as practicable, it is understood that the cells are to be operated in the manner recommended by the Contractor, but the necessities of operation must be the first consideration.

11. *Inspection.*

At all stages of manufacture the Purchaser must be given free access to the work in progress and the Contractor must give him every facility and assistance and furnish him with any tools, gauges, or instruments necessary for assuring himself that all the requirements of these specifications are met.

12. *Test.*

(a) The Contractor must give the Purchaser ample notice of the time when cells or parts will be finished and must co-operate to set a time convenient to the Purchaser for final inspection and test. The following test will be made on ten (10) per cent. of the number of cells ordered at the option of the Purchaser, and at the expense of the Contractor at his factory. The test cells may be picked out by the Purchaser from the proposed shipment and will be fully charged, then discharged and charged in the cycle indicated in the following table:

Nominal Capacity.	40 A.H.	80 A.H.	120 A.H.	200 A.H.	320 A.H.	400 A.H.
First Discharge						
Amperes	20	40	60	100	160	200
Hours, not less than	1	1	1	1	1	1
Minimum volts per cell, not less than ...	1.7	1.7	1.7	1.7	1.7	1.7
First Charge						
Amperes	7	14	21	35	56	70

Battery.
Storage.
Lead Type
Stationary.
Specifications.

12. *Tests*—Continued.

Nominal Capacity.	40 A.H.	80 A.H.	120 A.H.	200 A.H.	320 A H.	400 A.H.
Second Discharge.						
Amperes	5	10	15	25	40	50
Hours, not less than	8	8	8	8	8	8
Minimum volts per cell, not less than ...	1.75	1.75	1.75	1.75	1.75	1.75
Second Charge.						
Amperes	5	10	15	25	40	50

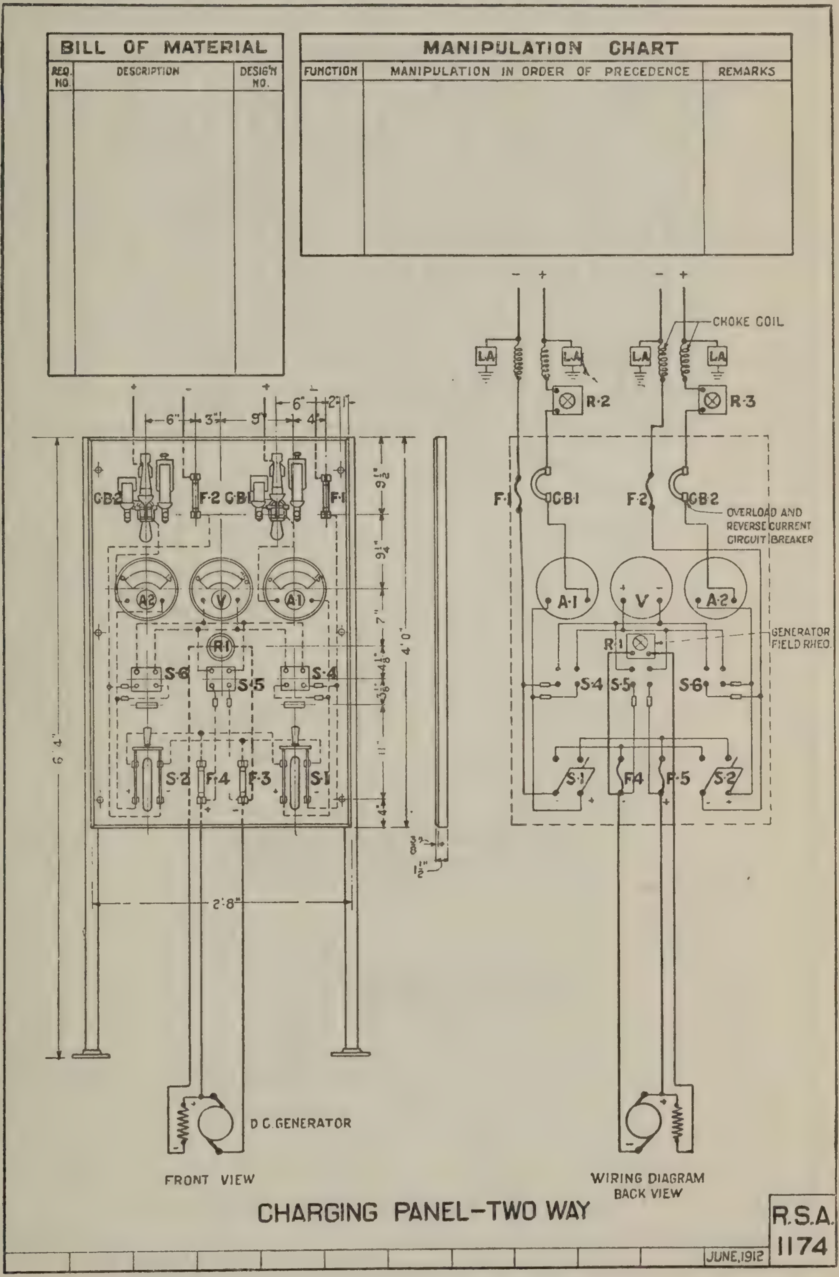
(b) During each charge and discharge, the current must be held constant as the value indicated in the table, and the voltage indicated must be measured while this current is flowing.

(c) The second charge must be completed in not more than one and eighteen one-hundredths (1.18) times the time consumed in the second discharge.

(d) If the average temperature of the electrolyte during the foregoing test is less than seventy (70) degrees Fahr., the time of discharge may be one (1) per cent. less than the time shown in the table, for each two (2) dedegrees Fahr. difference. If it is more than seventy (70) degrees Fahr., the time of discharge must be one (1) per cent. more than the time shown in the table for each four (4) degrees Fahr. difference.

(e) The variation in specific gravity and temperature of the electrolyte on discharge shall not be excessive.

(f) If positive and negative groups are ordered separately, the Purchaser may select samples not exceeding ten (10) per cent. of the whole number ordered and the Contractor will furnish for test the parts necessary for assembling them in complete cells and will make on these cells the tests here specified.


BILL OF MATERIAL
REQ. NO.
DESCRIPTION
DESIG'N NO.
MANIPULATION CHART
FUNCTION
MANIPULATION IN ORDER OF PRECEDENCE
REMARKS
CB·2
F·2
CB·1
F·1
A2
V
A1
R1
S·6
S·5
S·4
S·2
F·4
F·3
S·1
6"
3"
9"
6"
4"
2"
1"
9½"
9¼"
7"
4⅛"
3⅝"
11"
4"
4'0"
6'4"
2'8"
⅜"
1½"
D.C. GENERATOR
FRONT VIEW
CHOKE COIL
LA
R·2
R·3
F·1
CB·1
F·2
CB·2
OVERLOAD AND REVERSE CURRENT CIRCUIT BREAKER
A·1
V
A·2
GENERATOR FIELD RHEO.
R·1
S·4
S·5
S·6
S·1
F4
F·5
S·2
WIRING DIAGRAM BACK VIEW
R.S.A. 1174
JUNE, 1912

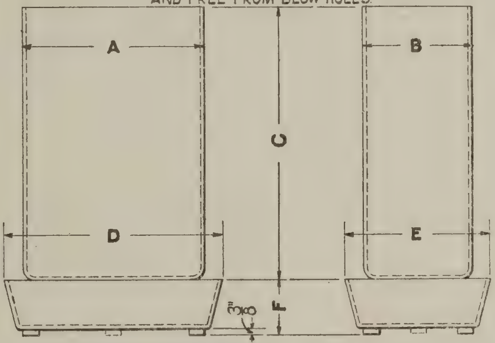
CHARGING PANEL—TWO WAY

TABLE OF DIMENSIONS

CAPACITY OF BATTERY AMP. HOUR	BATTERY JAR			SAND TRAY						CELL COVER	
	A	**B**	**C**	**D**		**E**		**F**		**P**	**Q**
				MIN	MAX	MIN	MAX.	MIN	MAX		
40	7 7/8"	4 3/4"	11"	9"	9 1/2"	6"	6 1/2"	1 1/2"	2"	3 7/8"	6"
80	9 1/8"	5 1/2"	12 3/4"	10 1/4"	10 3/4"	6 3/4"	7 1/4"	1 1/2"	2"	6 1/16"	6 3/4"
120	9 1/8"	6 3/4"	12 3/4"	10 1/4"	10 3/4"	8"	8 1/2"	1 1/2"	2"	6 1/16"	8"
200	9 1/8"	9 3/8"	12 3/4"	10 1/4"	10 3/4"	11"	12"	1 1/2"	2"	6 1/16"	10 3/4"
320	12 5/8"	9"	17"	14"	15"	11"	12"	2"	2 1/2"	8 1/16"	10 3/4"
400	12 5/8"	10 5/8"	17"	14"	15"	11 1/2"	12 1/2"	2"	2 1/2"	8 1/16"	11 3/4"

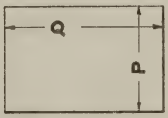
NOTE: A VARIATION OF 1/8" EACH WAY FROM STANDARD WILL BE PERMITTED IN DIMENSION "A."
A VARIATION OF 1/4" EACH WAY FROM STANDARD WILL BE PERMITTED IN DIMENSIONS "B" & "C."

NOTE - GLASS JARS TO BE CLEAR, UNIFORM AND FREE FROM BLOW HOLES.



GLASS SAND TRAY AND BATTERY JAR

SAND TRAYS FOR 320 & 400 A. H. JARS MUST HAVE 9 INSULATOR FEET



SHEET GLASS — 3/16" TO 1/4" THICK.
CORRUGATED ON ONE SIDE, PARALLEL TO "P" DIMENSION.

CELL COVER

LEAD TYPE STORAGE BATTERY

R.S.A.
1224

OCT. 1912

Cables.

CABLES.

AERIAL BRAIDED—For 660 Volts or Less, Specifications.

ARMORED SUBMARINE—For 660 Volts or Less, Specifications.

ARMORED SUBMARINE—For 2200 Volts, Specifications.

LEAD COVERED—For 660 Volts or Less, Specifications.

LEAD COVERED—For 2200 Volts, Specifications.

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SPECIFICATIONS FOR AERIAL BRAIDED CABLE FOR 660 VOLTS OR LESS.

1912.

1. *General.*

(a) Cable bought under these specifications will be used for ....current at ....volts and shall be ....feet in length.

(b) Workmanship and material shall be first-class and the best of their respective kinds and shall be in full accord with the best modern electrical and mechanical engineering practice.

2. *Cable.*

Cable shall consist of....................conductors insulated with rubber and laid into cable with jute laterals to make round. The assembly shall be taped and the core thus formed shall be wrapped with a closely-woven braid, as herein specified.

3. *Conductors.*

(a) Conductors shall be of the following sizes and numbers:

Number of conductors.	Approximate nearest size B. & S. gauge each conductor.	Number of strands.	Size of strands.	Actual c.m. of conductor.
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....

(b) Conductors must be of soft-drawn, annealed copper wire, having a conductivity of not less than ninety-eight (98) per cent. of that of pure copper, Matthiessen's standard. Each wire forming a conductor must be continuous without weld, splice or joint throughout its length, must be uniform in cross section, free from flaws, scales and other imperfections and provided with a heavy uniform coating of tin.

4. *Rubber insulation.*

(a) The rubber insulation shall be made exclusively from pure Upriver, fine, dry Para rubber, of best quality, which has not previously been used in a rubber com-

4. *Rubber insulation.*—Continued.

pound, solid waxy hydrocarbons, suitable mineral matter and sulphur, properly and thoroughly vulcanized. Before being mixed with the other ingredients the rubber shall be thoroughly washed and dried.

(b) Each of the dry mineral matter ingredients shall be thoroughly dried and passed through a sieve having not less than one hundred (100) meshes to the inch for the whiting and sixty (60) meshes to the inch for the other ingredients before they are mixed together.

(c) The ingredients used in the mixture shall be of a quality here specified and within the proportional limits by weight given in the following table:

Ingredient.	Percentage by weight.	
	Minimum.	Maximum.
Upriver, fine, dry Para rubber	30.5	32.
Whiting	....	30.
Zinc oxide	28.	As desired
Litharge	1.	12.
Sulphur	1.5	2.1
Ozokerite or paraffin	2.	3.

Ingredient.	Chemical composition.	Lowest grade acceptable.
Whiting	$CaCO_3$	96% pure
Zinc oxide	ZnO	Red seal

(d) The manufacturing processes shall be perfected to prevent, as far as practicable, excessive working of the rubber.

(e) The insulation must be homogeneous in character, tough, elastic, adhering to and be placed concentrically around the wire.

5. *Taping, filling and braiding.*

(a) The core of the cable must be made cylindrical in form and properly laid up with one (1) wire in each layer taped for a tracer. Cables of more than three (3) and less than seven (7) conductors shall be made up with a jute or sisal center. Each layer of core must have a spiral lay, each consecutive layer being spiraled in reverse direction from the preceding one. Where the number of conductors is such as to leave an open space between conductors in any layer, a jute filling must be supplied in

5. *Taping, filling and braiding.*—Continued.

such open space to completely fill out the layer. Over the last layer of conductors shall be placed a layer of rubber insulating tape overlapping for one-third (1/3) its width. The tape shall be of closely woven cotton, filled with rubber insulating compound and laid to make a smooth surface.

(b) Over the taped core shall be placed one (1) layer of closely woven cotton braiding at least one-thirty-second (1/32) inch thick, saturated with a black, insulating weatherproof compound that shall be neither injuriously affected by nor have an injurious effect on the braid at a temperature of two hundred (200) degrees Fahr.

8. *Acceptance.*

The product of those concerns only will be accepted who have satisfied the Purchaser that the requirements of these specifications will be complied with. The decision as to the quality of the cable furnished and the acceptance of the same shall be made by the Purchaser.

9. *Tests.*

(a) The Manufacturer shall provide, at his factory, apparatus and other facilities needed for making the required physical and electrical tests. The Purchaser shall have free access to the place of manufacture and opportunity for inspecting and testing the product at all stages of manufacture to show that the required amount and quality of Para rubber and other ingredients are being used in the compound.

(b) Tests shall be made from samples taken from any part of any coil and may also be made upon the finished product immediately after being delivered. If the requirements of these specifications are not met the wire will be rejected and the Manufacturer shall pay freight charges for the return of such material.

(c) At the option of the Purchaser, the wire after being tested, shall not be made into a cable until an analysis of a sample has been made by a chemist chosen by the Purchaser, and the results of such analysis as interpreted by the Purchaser, shall be sufficient ground for rejection should the wire or insulation not conform to the requirements of these specifications.

10. *Physical test of copper conductors.*

Each solid conductor must stand an elongation of twenty-five (25) per cent. of its length in ten (10) inches before breaking. It must be capable of being wrapped six (6) times about its diameter without showing signs of breakage.

11. *Conductivity test.*

The conductivity of the copper shall be determined by measuring the resistance of a length of wire and comparing with Matthiessen's standard of copper resistance.

12. *Tinning test.*

(a) Samples of wire shall be thoroughly cleaned with alcohol and immersed in hydrochloric acid of a specific gravity of 1.088 for one (1) minute. They shall then be rinsed in clear water and immersed in a solution of sodium sulphide of a specific gravity of 1.142 for thirty-two (32) seconds and again washed. This operation shall be repeated three (3) times and if the sample does not become blackened after the fourth immersion the tinning shall be regarded as satisfactory.

(b) The sodium sulphide solution must contain an excess of sulphur and should have sufficient strength to thoroughly blacken a piece of clean untinned copper wire in five (5) seconds.

15. *Physical tests of rubber insulation.*

(a) A sample of vulcanized rubber insulation not less than four (4) inches in length shall have marks placed upon it two (2) inches apart. The samples shall be stretched at the rate of three (3) inches per minute until the marks are six (6) inches apart and then at once released. One (1) minute after such release the marks shall not be over two and seven-sixteenths (2 7/16) inches apart. Samples shall then be stretched until the marks are nine (9) inches apart before breaking.

(b) The test to determine the tensile strength of the insulation shall be made upon as perfect a piece of vulcanized insulation as it is practicable to obtain from the wire being tested. The section of the test piece and the method of making the test shall be determined by the representative of the Purchaser, who shall as far as is consistent conform to the practices and requests of the Manufacturer.

(c) The tensile strength of the rubber insulation as shown by tests made on a carefully prepared sample shall

15. *Physical tests of rubber insulation.*—Continued.

be not less than twelve hundred (1200) pounds per square inch. The sample, for five (5) minutes before and as near as practicable during the test shall be maintained at a temperature of seventy (70) degrees Fahr.

(d) The specific gravity of the rubber insulation shall be not less than 1.85.

16. *Chemical tests of rubber insulation.*

The insulation shall show on analysis not less than thirty (30) nor more than thirty-three (33) per cent. of pure Upriver, fine, dry Para rubber, of best quality; not more than four (4) per cent. of waxy hydrocarbons, consisting of refined paraffin or pure ozokerite, not more than seven-tenths (0.7) of one per cent. of free sulphur, not more than two and five-tenths (2.5) per cent. total sulphur; freedom from all foreign matter and the mineral matter shall be such as will not have a deleterious effect on the insulation.

17. *Electrical tests of rubber insulation.*

(a) The thickness of the rubber insulation around each conductor (measured at the thinnest point), the minimum insulation resistance in megohms per mile when corrected to the standard temperature of sixty (60) degrees Fahr. and the dielectric strength shall conform to the following requirements:

B. & S. gauge	Thickness of insulation. Inch.	Insulation resistance megohms per mile.	Test voltage alternating current.
4	3/32	1600	5000
6	5/64	1600	4000
8	5/64	1900	4000
9	5/64	2000	4000
10	2/32	1900	3000
12	2/32	2200	3000
14	2/32	2600	3000
16	3/64	2600	2000

(b) The coils of wire after being removed from the vulcanizer shall be kept for twenty-four (24) hours at the normal temperature of the factory storeroom before being placed in the testing bath.

(c) The test for insulation resistance must be made upon all wire after at least twelve (12) hours' submersion in water and while still immersed results shall be corrected to a water temperature of sixty (60) degrees Fahr.

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17. *Electrical tests of rubber insulation.*—Continued.

Tests must be made with the wire in coils, suitable for examination and before the application of braid or other covering with a well insulated battery and galvanometer, with not less than one hundred (100) volts and readings must be taken after one (1) minute's electrification. The test voltage must be applied to the completed length of wire before the insulation test for a period of five (5) minutes, using alternating current from a generator and transformer of ample capacity.

(d) The insulation resistance at a given temperature shall be reduced to that at 60 degrees Fahr. by dividing by the coefficient corresponding to that temperature. The tests shall be made at a temperature within the scope of this table.

Temperature degrees Fahr.	Coefficient shall be not greater than.	Temperature degrees Fahr.	Coefficient shall be not less than.
46	1.44	60	1.000
47	1.41	61	.974
48	1.37	62	.949
49	1.34	63	.925
50	1.30	64	.901
51	1.27	65	.878
52	1.24	66	.855
53	1.20	67	.833
54	1.17	68	.812
55	1.14	69	.791
56	1.11	70	.771
57	1.09	71	.751
58	1.06	72	.732
59	1.03	73	.713
60	1.00	74	.695
		75	.677

(e) The cable, when made up after assembling and braiding, shall have the test voltage required for separate conductors, applied between conductors for five (5) minutes to each conductor.

(f) The insulation resistance of each conductor shall be measured after test voltage has been applied to the completed cable and the resistance found shall be not less than that specified for separate conductors.

18. *Inspection.*

The Manufacturer shall notify the Purchaser when the manufacture of the wire and cable is to begin in order that inspection may be arranged for.

19. *Reel.*

Each cable shall be placed on a separate reel holding the full length of cable. Both ends of cable must be accessible for testing but be covered and protected from injury. The flanges of the reel shall be large enough to protect the cable in handling and rolling, in addition to which the reel must be properly cleated. The reel will become the property of the Purchaser but must be taken back by the Manufacturer upon request of the Purchaser.

20. *Marking.*

Each reel shall have the weight, length, number of conductors in cable, the name of Manufacturer and Purchaser's order or inspection number plainly and indelibly marked on a strong tag securely fastened to the cable and also stenciled on the outside of the reel.

21. *Notification.*

The completed cable is not to be shipped from place of manufacture until permission in writing has been received from the Purchaser. Should the cable on arrival at destination be found defective and not comply with the specifications, it will be returned to the Manufacturer who must pay all freight charges.

SPECIFICATIONS FOR RUBBER INSULATED, ARMORED SUBMARINE CABLE FOR 660 VOLTS OR LESS.

1912.

1. *General.*

(a) Cable bought under these specifications will be used under water for........................current at ....volts and shall be ....feet in length.

(b) Workmanship and material shall be first-class and the best of their respective kinds and shall be in full accord with best modern electrical and mechanical engineering practice.

2. *Cable.*

Cable shall consist of.......................conductors insulated with rubber and laid into cable with jute laterals to make round. The assembly shall be taped and the core thus formed shall have lead sheath with jute covering over lead, with armor and a covering of jute over the armor as herein specified.

3. *Conductors.*

(a) Conductors shall be of the following sizes and numbers:

Number of conductors.	Approximate nearest size B. & S. gauge each conductor.	Number of strands.	Size of strands	Actual c.m. of conductor.
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....

(b) Conductors must be of soft-drawn, annealed copper wire, having a conductivity of not less than ninety-eight (98) per cent. of that of pure copper, Matthiessen's standard. Each wire forming a conductor must be continuous without weld, splice or joint throughout its length, must be uniform in cross section, free from flaws, scales and other imperfections and provided with a heavy uniform coating of tin.

4. *Rubber insulation.*

(a) The rubber insulation shall be made exclusively from pure Upriver, fine, dry Para rubber, of best quality, which has not previously been used in a rubber compound, solid waxy hydrocarbons, suitable mineral matter and sulphur, properly and thoroughly vulcanized. Before

4. *Rubber insulation.*—Continued.

being mixed with the other ingredients the rubber shall be thoroughly washed and dried.

(b) Each of the dry mineral matter ingredients shall be thoroughly dried and passed through a sieve having not less than one hundred (100) meshes to the inch for the whiting and sixty (60) meshes to the inch for the other ingredients before they are mixed together.

(c) The ingredients used in the mixture shall be of a quality here specified and within the proportional limits by weight given in the following table:

Ingredient.	Percentage by weight. Minimum.	Percentage by weight. Maximum.
Upriver, fine, dry Para rubber	30.5	32.
Whiting	....	30.
Zinc oxide	28.	As desired
Litharge	1.	12.
Sulphur	1.5	2.5
Ozokerite or paraffin	2.	3.

Ingredient.	Chemical composition.	Lowest grade acceptable.
Whiting	$CaCO_3$	96% pure
Zinc oxide	ZnO	Red seal

(d) The manufacturing processes shall be perfected to prevent, as far as practicable, excessive working of the rubber.

(e) The insulation must be homogeneous in character, tough, elastic, adhering to and be placed concentrically around the wire.

5. *Taping and filling.*

(a) The core of the cable must be made cylindrical in form and properly laid up with one (1) wire in each layer taped for a tracer. Cables of more than three (3) and less than seven (7) conductors shall be made up with a jute or sisal center. Each layer of core must have a spiral lay, each consecutive layer being spiraled in reverse direction from the preceding one. All interstices between insulated conductors must be thoroughly filled with dry jute to make round and covered with a layer of rubber insulating tape overlapping for one-third (1/3) its width.

(b) The tape shall be of closely woven cotton filled with rubber insulating compound and laid to make a smooth surface. The jute is to be well twisted and to be applied spirally.

6. *Sheath.*

A sheath, consisting of an alloy of lead and tin, containing not less than ninety-eight (98) per cent. pure lead and from one (1) to two (2) per cent. tin shall be applied over the assembled and taped conductors, and be of the following thickness for each of the different sizes of cables:

Diameter of cable over taping.	Thickness of lead sheath.
Under one (1) inch	3/32 inch.
One (1) to two (2) inches,	1/8 inch.
Over two (2) inches,	5/32 inch.

7. *Armoring and covering.*

A sheath shall be protected by one (1) layer of tarred jute, well twisted and applied spirally, and having a thickness of three thirty-seconds (3/32) of an inch. Over the jute covering shall be placed a covering consisting of galvanized E. B. B. wires applied spirally and laid to fit closely one wire to the next, these wires to be of the following gauge for the different sizes of cable:

Outside diameter over lead sheath and covering, inches.	B. W. G. armor wire.
1	10
1 1/4 to 1 1/2	8
1 3/4 to 2 1/4	6
2 1/2 to 3	4

(b) Over the armoring shall be placed two (2) layers of seventy (70) pound tarred or dry twisted jute roving saturated with a black, insulating weatherproof compound that shall be neither injuriously affected by, nor have an injurious effect upon the jute at 200 degrees Fahr.

8. *Acceptance.*

The product of those concerns only will be accepted who have satisfied the Purchaser that the requirements of these specifications will be complied with. The decision as to the quality of the cable furnished and the acceptance of the same shall be made by the Purchaser.

9. *Tests.* (a) The Manufacturer shall provide, at his factory, apparatus and other facilities needed for making the required physical and electrical tests. The Purchaser shall have free access to the place of manufacture and opportunity for inspecting and testing the product at all stages of manufacture to show that the required amount and quality of Para rubber and other ingredients are being used in the compound.

9. *Tests.*—Continued.

(b) Tests shall be made from samples taken from any part of any coil of wire and shall also be made upon the finished product before, and if desired, immediately after being delivered. If the requirements of these specifications are not met the cable will be rejected.

(c) At the option of the Purchaser, the wire after being tested, shall not be made into a cable until an analysis of a sample has been made by a chemist chosen by the Purchaser, and the results of such analysis as interpreted by the Purchaser, shall be sufficient ground for rejection should the wire or insulation not conform to the requirements of these specifications.

10. *Physical test of copper conductors.*

Each solid conductor must stand an elongation of twenty-five (25) per cent. of its length in ten (10) inches before breaking. It must be capable of being wrapped six (6) times about its diameter without showing signs of breakage.

11. *Conductivity test.*

The conductivity of the copper shall be determined by measuring the resistance of a length of wire and comparing with Matthiessen's standard of copper resistance.

12. *Tinning test.*

(a) Samples of wire shall be thoroughly cleaned with alcohol and immersed in hydrochloric acid of a specific gravity of 1.088 for one (1) minute. They shall then be rinsed in clear water and immersed in a solution of sodium sulphide of a specific gravity of 1.142 for thirty-two (32) seconds and again washed. This operation shall be repeated three (3) times and if the sample does not become clearly blackened after the fourth immersion the tinning shall be regarded as satisfactory.

(b) The sodium sulphide solution must contain an excess of sulphur and should have sufficient strength to thoroughly blacken a piece of clean untinned copper wire in five (5) seconds.

13. *Test of armor wire galvanizing.*

(a) A sufficient number of samples shall be taken from the wire submitted for inspection and shall be tested, these pieces being not less than eight (8) inches long and not more than seven (7) pieces of wire shall be immersed in the specified quantity of solution.

13. *Test of armor wire galvanizing.*—Continued.

(b) The samples shall be cleaned before being tested, first with carbona, benzine or turpentine and cotton waste and then thoroughly rinsed in clean water and wiped dry with clean cotton waste. The samples shall be cleaned and dried before being immersed in the solution. The samples, when placed in the solution, shall be well separated to permit the solution to act uniformly on all immersed portions of the samples.

(c) The samples shall be tested in a neutral solution of commercial copper sulphate having a specific gravity of 1.186 at a temperature of sixty-five (65) degrees Fahr. The solution shall be neutralized by the addition of excess of chemically pure cupric oxide (CuO) which will collect in the bottom of the containing vessel. The solution shall be filtered before being used. Not less than four (4) ounces of fresh solution shall be used for each test of seven (7) wires. The solution must be maintained at a temperature between sixty-two (62) and sixty-eight (68) degrees Fahr. during the test. The samples shall be immersed in the solution for one (1) minute, shall then be washed in clean water having a temperature of between sixty-two (62) and sixty-eight (68) degrees Fahr. and be wiped dry with clean cotton waste. This operation shall be performed four (4) times.

(d) If there is a bright metallic copper deposit on the samples after the fourth immersion the wire, represented by the samples, shall be rejected, but copper deposited on zinc or within one (1) inch of the end of the sample shall not be considered as cause for rejection.

(e) In case of a failure of one (1) wire in the group of seven (7) being tested together, or if there is reasonable doubt as to the copper deposit, two (2) check tests shall be made of samples from the same coil, but unless the two (2) check tests are satisfactory the wire shall be rejected.

14. *Test of armor wire tensile strength.*

The tensile strength and elongation of the various sizes of armor shall conform to the following requirements:

B. W. gauge.	Breaking strength in pounds.	Per cent. elongation in 10 inches.
4	2028	18
6	1475	18
8	975	15
10	645	15

15. *Physical tests of rubber insulations.*

(a) A sample of vulcanized rubber insulation not less than four (4) inches in length shall have marks placed upon it two (2) inches apart. The samples shall be stretched at the rate of three (3) inches per minute until the marks are six (6) inches apart and then at once released. One (1) minute after such release the marks shall not be over two and seven-sixteenths (2 7/16) inches apart. Samples shall then be stretched until the marks are nine (9) inches apart before breaking.

(b) The test to determine the tensile strength of the insulation shall be made upon as perfect a piece of vulcanized insulation as it is practicable to obtain from the wire being tested. The section of the test piece and the method of making the test shall be determined by the representative of the Purchaser, who shall as far as is consistent conform to the practices and requests of the Manufacturer.

(c) The tensile strength of the rubber insulation as shown by tests made on a carefully prepared sample shall be not less than twelve hundred (1200) pounds per square inch. The sample, for five (5) minutes before and as near as practicable during the test shall be maintained at a temperature of seventy (70) degrees Fahr.

(d) The specific gravity of the rubber insulation shall be not less than 1.85.

16. *Chemical tests of rubber insulation.*

(a) The insulation shall show on analysis not less than thirty (30) nor more than thirty-three (33) per cent. of pure Upriver, fine, dry Para rubber, of best quality; not more than four (4) per cent. of waxy hydrocarbons, consisting of refined paraffin or pure ozokerite; not more than seven-tenths (0.7) of one per cent. of free sulphur; not more than two and five-tenths (2.5) per cent. total sulphur, freedom from all foreign matter and the mineral matter shall be such as will not have a deleterious effect on the insulation.

(b) The rubber extractive in the vulcanized compound shall vary between the limits nine-tenths (0.9) and one and thirty-five one-hundredths (1.35) per cent. The vulcanized compound before being extracted with acetone shall be reduced in size sufficiently to pass through a twenty (20) mesh sieve.

17. *Electrical tests of rubber insulation.*

(a) The thickness of the rubber insulation around each conductor (measured at the thinnest point), the minimum insulation resistance in megohms per mile when corrected to the standard temperature of sixty (60) degrees Fahr. and the dielectric strength shall conform to the following requirements:

B. & S. gauge	Thickness of insulation. Inch.	Insulation resistance megohms per mile.	Test voltage alternating current.
0	4/32	1300	8000
1	4/32	1500	8000
2	4/32	1600	8000
4	3/32	1600	5000
6	3/32	1800	5000
8	3/32	2200	5000
9	5/64	2000	4000
10	5/64	2200	4000
12	5/64	2500	4000
14	5/64	2800	4000
16	2/32	2800	3000

(b) The coils of wire after being removed from the vulcanizer shall be kept for twenty-four (24) hours at the normal temperature of the factory storeroom before being placed in the testing bath.

(c) The test for insulation resistance must be made upon all wire after at least twelve (12) hours' submersion in water and while still immersed results shall be corrected to a water temperature of sixty (60) degrees Fahr. Tests must be made with the wire in coils, suitable for examination and before the application of tape or other covering with a well insulated battery and galvanometer, with not less than one hundred (100) volts and readings must be taken after one (1) minute's electrification. The test voltage must be applied to the completed length of wire before the insulation test for a period of five (5) minutes, using alternating current from a generator and transformer of ample capacity.

(d) The insulation resistance at a given temperature shall be reduced to that at 60 degrees Fahr. by dividing by the coefficient corresponding to that temperature. The tests shall be made at a temperature within the scope of this table.

17. *Electrical tests of rubber insulation.*—Continued.

Temperature degrees Fahr.	Coefficient shall be not greater than.	Temperature degrees Fahr.	Coefficient shall be not less than.
46	1.44	60	1.000
47	1.41	61	.974
48	1.37	62	.949
49	1.34	63	.925
50	1.30	64	.901
51	1.27	65	.878
52	1.24	66	.855
53	1.20	67	.833
54	1.17	68	.812
55	1.14	69	.791
56	1.11	70	.771
57	1.09	71	.751
58	1.06	72	.732
59	1.03	73	.713
60	1.00	74	.695
		75	.677

(e) The cable, when made up after assembling with lead covering and armoring, shall have the test voltage applied for five (5) minutes to each conductor, as follows:

1. Between conductors apply the full voltage test as required for separate wires.
2. Between each conductor and lead sheath apply a test voltage of but sixty (60) per cent. of that required for separate wires.

(f) The insulation resistance of each conductor shall be measured after test voltage has been applied to the completed cable and the resistance found shall be not less than that specified for separate conductors.

18. *Inspection.*

The Manufacturer shall notify the Purchaser when the manufacture of the wire and cable is to begin in order that inspection may be arranged for.

19. *Reel.*

Each cable shall be placed on a separate reel holding the full length of cable. Both ends of cable must be accessible for testing but be covered and protected from injury. The flanges of the reel shall be large enough to protect the cable in handling and rolling, in addition to which the reel must be properly cleated. The reel will become the property of the Purchaser but must be taken back by the Manufacturer upon request of the Purchaser.

20. *Marking.*

Each reel shall have the weight, length, number of conductors in cable, the name of Manufacturer and Purchaser's order or inspection number plainly and indelibly marked on a strong tag securely fastened to the cable and also stenciled on the outside of the reel.

21. *Notification.*

The completed cable is not to be shipped from place of manufacture until permission in writing has been received from the Purchaser. Should the cable on arrival at destination be found defective and not comply with the specifications, it will be returned to the Manufacturer who must pay all freight charges.

SPECIFICATIONS FOR ARMORED SUBMARINE CABLES FOR 2200 VOLTS.

1912.

1. *General.*

(a) Cable bought under these specifications will be used under water for........................current at twenty-two hundred (2200) volts and shall be........................ feet in length.

(b) Workmanship and material shall be first-class and the best of their respective kinds and shall be in full accord with the best modern electrical and mechanical engineering practice.

2. *Cable.*

Cable shall consist of .... conductors insulated with rubber and laid into cable with jute laterals to make round. The whole to be taped and the core thus formed shall have lead sheath with jute covering over lead, with armor and a covering of jute over the armor as herein specified.

3. *Conductors.*

(a) Conductors shall be of the following sizes and numbers:

Number of conductors.	Approximate nearest size B. & S. gauge each conductor.	Number of strands.	Size of strands.	Actual c.m. of conductor.
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....

(b) Conductors must be of soft-drawn, annealed copper wire having a conductivity of not less than ninety-eight (98) per cent. of that of pure copper, Matthiessen's standard. Each wire forming a conductor must be continuous without weld, splice or joint throughout its length, must be uniform in cross section, free from flaws, scales and other imperfections and provided with a heavy uniform coating of tin.

4. *Rubber insulation.*

(a) The rubber insulation shall be made exclusively from pure Upriver fine, dry Para rubber, of best quality, which has not previously been used in a rubber compound, solid, waxy hydrocarbons, suitable mineral mat-

4. *Rubber insulation.*—Continued.

ter and sulphur, properly and thoroughly vulcanized. Before being mixed with the other ingredients the rubber shall be thoroughly washed and dried.

(b) Each of the dry mineral matter ingredients shall be thoroughly dried and passed through a sieve having not less than one hundred (100) meshes to the inch for the whiting and sixty (60) meshes to the inch for the other ingredients before they are mixed together.

(c) The ingredients used in the mixture shall be of a quality here specified and within the proportional limits by weight given in the following table:

Ingredient.	Percentage by weight.	
	Minimum.	Maximum.
Upriver, fine, dry Para rubber	30.5	32.
Whiting	....	30.
Zinc oxide	28.	As desired
Litharge	1.	12.
Sulphur	1.5	2.5
Ozokerite or paraffin	2.	3.

Ingredient	Chemical composition.	Lowest grade acceptable.
Whiting	$CaCO_3$	96% pure
Zinc oxide	ZnO	Red seal

(d) The manufacturing processes shall be perfected to prevent, as far as practicable, excessive working of the rubber.

(e) The insulation must be homogeneous in character, tough, elastic, adhering to and be placed concentrically around the wire.

5. *Taping and filling.*

(a) The core of the cable must be made cylindrical in form and properly laid up with one (1) wire in each layer taped for a tracer. Cables of more than three (3) and less than seven (7) conductors shall be made up with a jute or sisal center. Each layer of core must have a spiral lay, each consecutive layer being spiraled in reverse direction from the preceding one. All interstices between insulated conductors must be thoroughly filled with dry jute to make round and covered with a layer of rubber insulating tape overlapping for one-third (1/3) its width.

5. *Taping and filling.*—Continued.

(b) The tape shall be of closely woven cotton filled with rubber insulating compound and laid to make a smooth surface. The jute is to be well twisted and to be applied spirally.

6. *Sheath.*

A sheath, consisting of an alloy of lead and tin, containing not less than ninety-eight (98) per cent. pure lead and from one (1) to two (2) per cent. tin shall be applied over the assembled and taped conductors, and be of the following thickness for each of the different sizes of cables:

Diameter of cable over taping.	Thickness of lead sheath.
Under one (1) inch	3/32 inch.
One (1) to two (2) inches,	1/8 inch.
Over two (2) inches,	5/32 inch.

7. *Armoring and covering.*

(a) The sheath shall be protected by one (1) layer of tarred jute, well twisted and applied spirally, and having a thickness of three thirty-seconds (3/32) of an inch. Over the jute covering shall be placed a covering consisting of galvanized E. B. B. wires applied spirally and laid to fit closely one wire to the next, these wires to be of the following gauge for the different sizes of cable:

Outside diameter over lead sheath and covering, inches.	B. W. G. armor wire.
1	10
1 1/4 to 1 1/2	8
1 3/4 to 2 1/4	6
2 1/2 to 3	4

(b) Over the armoring shall be placed two (2) layers of seventy (70) pound tarred or dry twisted jute roving saturated with a black, insulating weatherproof compound that shall be neither injuriously affected by, nor have an injurious effect upon the jute at 200 degrees Fahr.

8. *Acceptance.*

The product of those concerns only will be accepted who have satisfied the Purchaser that the requirements of these specifications will be complied with. The decision as to the quality of the cable furnished and the acceptance of the same shall be made by the Purchaser.

9. *Tests.*

(a) The Manufacturer shall provide, at his factory, apparatus and other facilities needed for making the required physical and electrical tests. The Manufacturer shall give free access to the place of manufacture and opportunity for inspecting and testing the product at all stages of manufacture to show that the required amount and quality of Para rubber and other ingredients are being used in the compound.

(b) Tests shall be made from samples taken from any part of any coil of wire and shall also be made upon the finished product before, and if desired, immediately after being delivered. If the requirements of these specifications are not met the cable will be rejected.

(c) At the option of the Purchaser, the wire after being tested shall not be made into a cable until an analysis of a sample has been made by a chemist, chosen by the Purchaser, and the results of such analysis as interpreted by the Purchaser, shall be sufficient ground for rejection should the wire or insulation not conform to the requirements of these specifications.

10. *Physical test of copper conductors.*

Each solid conductor must stand an elongation of twenty-five (25) per cent. of its length in ten (10) inches before breaking. It must be capable of being wrapped six (6) times about its diameter without showing signs of breakage.

11. *Conductivity test.*

The conductivity of the copper shall be determined by measuring the resistance of a length of wire and comparing with Matthiessen's standard of copper resistance.

12. *Tinning test.*

(a) Samples of wire shall be thoroughly cleaned with alcohol and immersed in hydrochloric acid of a specific gravity of 1.088 for one (1) minute. They shall then be rinsed in clear water and immersed in a solution of sodium sulphide of a specific gravity of 1.142 for thirty-

12. *Tinning Test.*—Continued.

two (32) seconds and again washed. This operation shall be repeated three (3) times and if the sample does not become clearly blackened after the fourth immersion, the tinning shall be regarded as satisfactory.

(b) The sodium sulphide solution must contain an excess of sulphur and should have sufficient strength to thoroughly blacken a piece of clean untinned copper wire in five (5) seconds.

13. *Test of armor wire galvanizing.*

(a) A sufficient number of samples shall be taken from the wire submitted for inspection and shall be tested, these pieces being not less than eight (8) inches long and not more than seven (7) pieces of wire shall be immersed in the specified quantity of solution.

(b) The samples shall be cleaned before being tested, first with carbona, benzine or turpentine and cotton waste and then thoroughly rinsed in clean water and wiped dry with clean cotton waste. The samples shall be cleaned and dried before being immersed in the solution. The samples, when placed in the solution, shall be well separated to permit the solution to act uniformly on all immersed portions of the samples.

(c) The samples shall be tested in a neutral solution of commercial copper sulphate having a specific gravity of 1.186 at a temperature of sixty-five (65) degrees Fahr. The solution shall be neutralized by the addition of excess of chemically pure cupric oxide (CuO) which will collect in the bottom of the containing vessel. The solution shall be filtered before being used. Not less than four (4) ounces of fresh solution shall be used for each test of seven (7) wires. The solution must be maintained at a temperature between sixty-two (62) and sixty-eight (68) degrees Fahr. during the test. The samples shall be immersed in the solution for one (1) minute, shall then be washed in clean water having a temperature of between sixty-two (62) and sixty-eight (68) degrees Fahr. and be wiped dry with clean cotton waste. This operation shall be performed four (4) times.

(d) If there is a bright metallic copper deposit on the samples after the fourth immersion the wire, represented by the samples, shall be rejected, but copper deposited on zinc or within one (1) inch of the end of the sample shall not be considered as cause for rejection.

13. *Test of armor wire galvanizing.*—Continued.

(e) In case of a failure of one (1) wire in the group of seven (7) being tested together, or if there is reasonable doubt as to the copper deposit, two (2) check tests shall be made of samples from the same coil, but unless the two (2) check tests are satisfactory the wire shall be rejected.

14. *Test of armor wire tensile strength.*

The tensile strength and elongation of the various sizes of armor shall conform to the following requirements:

B. W. gauge.	Breaking strength in pounds.	Per cent. elongation in ten inches.
4	2028	18
6	1475	18
8	975	15
10	645	15

15. *Physical tests of rubber insulations.*

(a) A sample of the vulcanized rubber insulation not less than four (4) inches in length shall have marks placed upon it two (2) inches apart. The sample shall be stretched at the rate of three (3) inches per minute until the marks are six (6) inches apart and then at once released. One (1) minute after such release the marks shall not be over two and seven-sixteenths (2 7/16) inches apart. The sample shall then be stretched until the marks are nine (9) inches apart before breaking.

(b) The test to determine the tensile strength of the insulation shall be made upon as perfect a piece of vulcanized insulation as it is practicable to obtain from the wire being tested. The section of the test piece and the method of making the test shall be determined by the representative of the Purchaser, who shall as far as is consistent conform to the practices and requests of the Manufacturer.

(c) The tensile strength of the rubber insulation as shown by tests made on a carefully prepared sample shall be not less than twelve hundred (1200) pounds per square inch. The sample, for five (5) minutes before and as near as practicable during the test, shall be maintained at a temperature of seventy (70) degrees Fahr.

(d) The specific gravity of the rubber insulation shall be not less than 1.85.

16. *Chemical tests of rubber insulation.*

(a) The insulation shall show on analysis not less than thirty (30) nor more than thirty-three (33) per cent. of pure Upriver fine, dry Para rubber, of best quality; not more than four (4) per cent. of waxy hydrocarbons, consisting of refined paraffin or pure ozokerite; not more than seven-tenths (0.7) of one per cent. of free sulphur; not more than two and five-tenths (2.5) per cent. total sulphur, freedom from all foreign matter and the mineral matter shall be such as will not have a deleterious effect on the insulation.

(b) The rubber extractive in the vulcanized compound shall vary between the limits nine-tenths (0.9) and one and thirty-five one-hundredths (1.35) per cent. The vulcanized compound before being extracted with acetone shall be reduced in size sufficiently to pass through a twenty (20) mesh sieve.

17. *Electrical tests of rubber insulation.*

(a) The thickness of the rubber insulation around each conductor, (measured at the thinnest point,) the minimum insulation resistance in megohms per mile, when corrected to the standard temperature of sixty (60) degrees Fahr. and the dielectric strength shall conform to the following requirements:

B. & S. gauge.	Thickness of insulation. Inch.	Insulation resistance megohms per mile.	Test voltage alternating current.
0000	8/32	2400	10,000
000	8/32	2600	10,000
00	8/32	2900	10,000
0	8/32	3100	10,000
1	8/32	3300	10,000
2	8/32	3700	10,000
4	6/32	3400	8,000
6	6/32	4000	8,000
8	6/32	4600	8,000

(b) The coils of wire after being removed from the vulcanizer shall be kept for twenty-four (24) hours at the normal temperature of the factory storeroom before being placed in the testing bath.

(c) The test for insulation resistance must be made upon all wire after at least twelve (12) hours submersion

17. *Electrical tests of rubber insulation*—Continued.

in water and while still immersed results be corrected to a water temperature of sixty (60) degrees Fahr. Tests must be made with the wire in coils, suitable for examination and before the application of tape or other covering with a well insulated battery and galvanometer, with not less than one hundred (100) volts and readings must be taken after one (1) minute's electrification. The test voltage must be applied to the completed length of wire before the insulation test for a period of five (5) minutes, using alternating current from a generator and transformer of ample capacity.

(d) The insulation resistance (megohms) at a given temperature shall be reduced to that at sixty (60) degrees Fahr., by dividing by the coefficient corresponding to that temperature. The tests shall be made at temperature within the scope of this table.

Temperature degrees Fahr.	Coefficient shall be not greater than.	Temperature degrees Fahr.	Coefficient shall be not less than.
46	1.44	60	1.000
47	1.41	61	.974
48	1.37	62	.949
49	1.34	63	.925
50	1.30	64	.901
51	1.27	65	.878
52	1.24	66	.855
53	1.20	67	.833
54	1.17	68	.812
55	1.14	69	.791
56	1.11	70	.771
57	1.09	71	.751
58	1.06	72	.732
59	1.03	73	.713
60	1.00	74	.695
		75	.677

(e) The cable when made up after assembling with lead covering and armoring shall have the test voltage applied for five (5) minutes to each conductor, as follows:

1. Between conductors apply the full voltage test as required for separate wires.

17. *Electrical tests of rubber insulation.*—Continued.

2. Between each conductor and lead sheath apply a test voltage of but sixty (60) per cent. of that required for separate wires.

(f) The insulation resistance of each conductor shall be measured after test voltage has been applied to the completed cable and the resistance found shall be not less than that specified for separate conductors.

18. *Inspection.*

The Manufacturer shall notify the Purchaser when the manufacture of the wire and cable is to begin in order that inspection may be arranged for.

19. *Reel.*

Each cable shall be placed on a separate reel holding the full length of cable. Both ends of cable must be accessible for testing but be covered and protected from injury. The flanges of the reel shall be large enough to protect the cable in handling and rolling, in addition to which the reel must be properly cleated. The reel will become the property of the Purchaser but must be taken back by the Manufacturer upon the request of the Purchaser.

20. *Marking.*

Each reel shall have the weight, length, number of conductors in cable, the name of Manufacturer and Purchaser's order or inspection number plainly and indelibly marked on a strong tag securely fastened to the cable and also stenciled on the outside of the reel.

21. *Notification.*

The completed cable is not to be shipped from place of manufacture until permission in writing has been received from the Purchaser. Should the cable on arrival at destination be found defective and not comply with these specifications, it will be returned to the Manufacturer, who must pay all freight charges.

SPECIFICATIONS FOR LEAD COVERED CABLE FOR 660 VOLTS OR LESS.

1912.

1. *General.*

(a) Cable bought under these specifications will be used for ....current at ....volts and shall be ....feet in length.

(b) Workmanship and material shall be first-class and the best of their respective kinds and shall be in full accord with the best modern electrical and mechanical engineering practice.

2. *Cable.*

Cable shall consist of.....................conductors insulated with rubber and laid into cable with jute laterals to make round. The assembly to be taped and over the core thus formed a lead sheath shall be placed.

3. *Conductors.*

(a) Conductors shall be of the following sizes and numbers:

Number of conductors.	Approximate nearest size B. & S. gauge each conductor.	Number of strands.	Size of strands	Actual c.m. of conductors.
......	....	....	....	....
......	....	....	....	....
......	....	....	....	....

(b) Conductors must be of soft-drawn, annealed copper wire, having a conductivity of not less than ninety-eight (98) per cent. of that of pure copper, Matthiessen's standard. Each wire forming a conductor must be continuous without weld, splice or joint throughout its length, must be uniform in cross section, free from flaws, scales and other imperfections and provided with a heavy uniform coating of tin.

4. *Rubber insulation.*

(a) The rubber insulation shall be made exclusively from pure Upriver, fine, dry Para rubber, of best quality, which has not previously been used in a rubber compound, solid waxy hydrocarbons, suitable mineral matter and sulphur, properly and thoroughly vulcanized. Before

4. *Rubber insulation.*—Continued.

being mixed with the other ingredients the rubber shall be thoroughly washed and dried.

(b) Each of the dry mineral matter ingredients shall be thoroughly dried and passed through a sieve having not less than one hundred (100) meshes to the inch for the whiting and sixty (60) meshes to the inch for the other ingredients before they are mixed together.

(c) The ingredients used in the mixture shall be of a quality here specified and within the proportional limits by weight given in the following table:

Ingredient.	Percentage by weight.	
	Minimum.	Maximum.
Upriver, fine, dry Para rubber	30.5	32.
Whiting	....	30.
Zinc oxide	28.	As desired
Litharge	1.	12.
Sulphur	1.5	2.5
Ozokerite or paraffin	2.	3.

Ingredient	Chemical composition.	Lowest grade acceptable.
Whiting	$CaCO_3$	96% pure
Zinc oxide	ZnO	Red seal

(d) The manufacturing processes shall be perfected to prevent, as far as practicable, excessive working of the rubber.

(e) The insulation must be homogeneous in character, tough, elastic, adhering to and be placed concentrically around the wire.

5. *Taping and filling.*

(a) The core of the cable must be made cylindrical in form and properly laid up with one (1) wire in each layer taped for a tracer. Cables of more than three (3) and less than seven (7) conductors shall be made up with a jute or sisal center. Each layer of core must have a spiral lay, each consecutive layer being spiraled in reverse direction from the preceding one. All interstices between insulated conductors must be thoroughly filled with dry jute to make round and covered with a layer of rubber insulating tape overlapping for one-third (1/3) its width.

(b) The tape shall be of closely woven cotton filled with rubber insulating compound and laid to make a smooth surface. The jute is to be well twisted and to be applied spirally.

6. *Sheath.*

A sheath, consisting of an alloy of lead and tin, containing not less than ninety-eight (98) per cent. pure lead and from one (1) to two (2) per cent. tin shall be applied over the assembled and taped conductors, and be of the following thickness for each of the different sizes of cables:

Diameter of cable over taping.	Thickness of lead sheath.
Under one (1) inch	3/32 inch.
One (1) to two (2) inches,	1/8 inch.
Over two (2) inches,	5/32 inch.

8. *Acceptance.*

The product of those concerns only will be accepted who have satisfied the Purchaser that the requirements of these specifications will be complied with. The decision as to the quality of the cable furnished and the acceptance of the same shall be made by the Purchaser.

9. *Tests.*

(a) The Manufacturer shall provide, at his factory, apparatus and other facilities needed for making the required physical and electrical tests.

(b) The Manufacturer shall give free access to the place of manufacture, and opportunity for inspecting and testing the product at all stages of manufacture to show that the required amount and quality of Para rubber and other ingredients are being used in the compound.

(c) Tests shall be made from samples taken from any part of any coil of wire and shall also be made upon the finished product before, and if desired, immediately after being delivered. If the requirements of these specifications are not met the cable will be rejected.

(d) At the option of the Purchaser, the wire after being tested shall not be made into a cable until an analysis of a sample has been made by a chemist, chosen by the Purchaser, and the results of such analysis as interpreted by the Purchaser, shall be sufficient ground for rejection should the wire or insulation not conform to the requirements of these specifications.

10. *Physical test of copper conductors.*

Each solid conductor must stand an elongation of twenty-five (25) per cent. of its length in ten (10) inches before breaking. It must be capable of being wrapped six (6) times about its diameter without showing signs of breakage.

11. *Conductivity test.*

The conductivity of the copper shall be determined by measuring the resistance of a length of wire and comparing with Matthiessen's standard of copper resistance.

12. *Tinning test.*

(a) Samples of wire shall be thoroughly cleaned with alcohol and immersed in hydrochloric acid of a specific gravity of 1.088 for one (1) minute. They shall then be rinsed in clear water and immersed in a solution of sodium sulphide of a specific gravity of 1.142 for thirty-two (32) seconds and again washed. This operation shall be repeated three (3) times and if the sample does not become blackened after the fourth immersion the tinning shall be regarded as satisfactory.

(b) The sodium sulphide solution must contain an excess of sulphur and should have sufficient strength to thoroughly blacken a piece of clean untinned copper wire in five (5) seconds.

15. *Physical tests of rubber insulation.*

(a) A sample of vulcanized rubber insulation not less than four (4) inches in length shall have marks placed upon it two (2) inches apart. The samples shall be stretched at the rate of three (3) inches per minute until the marks are six (6) inches apart and then at once released. One (1) minute after such release the marks shall not be over two and seven-sixteenths (2 7/16) inches apart. Samples shall then be stretched until the marks are nine (9) inches apart before breaking.

(b) The test to determine the tensile strength of the insulation shall be made upon as perfect a piece of vulcanized insulation as it is practicable to obtain from the wire being tested. The section of the test piece and the method of making the test shall be determined by the representative of the Purchaser, who shall as far as is consistent conform to the practices and requests of the Manufacturer.

(c) The tensile strength of the rubber insulation as shown by tests made on a carefully prepared sample shall be not less than twelve hundred (1200) pounds per square inch. The sample, for five (5) minutes before and as near as practicable during the test shall be maintained at a temperature of seventy (70) degrees Fahr.

15. *Physical tests of rubber insulation.*—Continued.

(d) The specific gravity of the rubber insulation shall be not less than 1.85.

16. *Chemical tests of rubber insulation.*

The insulation shall show on analysis not less than thirty (30) nor more than thirty-three (33) per cent. of pure Upriver, fine, dry Para rubber, of best quality; not more than four (4) per cent. of waxy hydrocarbons, consisting of refined paraffin or pure ozokerite, not more than seven-tenths (0.7) of one per cent. of free sulphur, not more than two and five-tenths (2.5) per cent. total sulphur; freedom from all foreign matter and the mineral matter shall be such as will not have a deleterious effect on the insulation.

17. *Electrical tests of rubber insulation.*

(a) The thickness of the rubber insulation around each conductor (measured at the thinnest point), the minimum insulation resistance in megohms per mile when corrected to the standard temperature of sixty (60) degrees Fahr. and the dielectric strength shall conform to the following requirements:

B. & S. gauge.	Thickness of insulation. Inch.	Insulation resistance megohms per mile.	Test voltage alternating current.
0	4/32	1300	8000
1	4/32	1500	8000
2	3/32	1400	5000
4	3/32	1600	5000
6	5/64	1600	4000
8	5/64	1900	4000
9	5/64	2000	4000
10	2/32	1900	3000
12	2/32	2200	3000
14	2/32	2600	3000
16	3/64	2600	2000

(b) The coils of wire after being removed from the vulcanizer shall be kept for twenty-four (24) hours at the normal temperature of the factory storeroom before being placed in the testing bath.

(c) The test for insulation resistance must be made upon all wire after at least twelve (12) hours' submersion in water and while still immersed results shall be corrected to a water temperature of sixty (60) degrees Fahr.

17. *Electrical tests of rubber insulation.*—Continued.

Tests must be made with the wire in coils, suitable for examination and before the application of braid or other covering with a well insulated battery and galvanometer, with not less than one hundred (100) volts and readings must be taken after one (1) minute's electrification. The test voltage must be applied to the completed length of wire before the insulation test for a period of five (5) minutes, using alternating current from a generator and transformer of ample capacity.

(d) The insulation resistance at a given temperature shall be reduced to that at 60 degrees Fahr. by dividing by the coefficient corresponding to that temperature. The tests shall be made at a temperature within the scope of this table.

Temperature degrees Fahr.	Coefficient shall be not greater than.	Temperature degrees Fahr.	Coefficient shall be not less than.
46	1.44	60	1.000
47	1.41	61	.974
48	1.37	62	.949
49	1.34	63	.925
50	1.30	64	.901
51	1.27	65	.878
52	1.24	66	.855
53	1.20	67	.833
54	1.17	68	.812
55	1.14	69	.791
56	1.11	70	.771
57	1.09	71	.751
58	1.06	72	.732
59	1.03	73	.713
60	1.00	74	.695
		75	.677

(e) The cable, when made up after assembling with lead covering, shall have the test voltage applied for five (5) minutes to each conductor, as follows:

1. Between conductors apply the full voltage test as required for separate wires.

2. Between each conductor and lead sheath apply a test voltage of but sixty (60) per cent. of that required for separate wires.

17. *Electrical tests of rubber insulation.*—Continued.

(f) The insulation resistance of each conductor shall be measured after test voltage has been applied to the completed cable and the resistance found shall be not less than that specified for separate conductors.

18. *Inspection.*

The Manufacturer shall notify the Purchaser when the manufacture of the wire and cable is to begin in order that inspection may be arranged for.

19. *Reel.*

Each cable shall be placed on a separate reel holding the full length of cable. Both ends of cable must be accessible for testing but be covered and protected from injury. The flanges of the reel shall be large enough to protect the cable in handling and rolling, in addition to which the reel must be properly cleated. The reel will become the property of the Purchaser but must be taken back by the Manufacturer upon request of the Purchaser.

20. *Marking.*

Each reel shall have the weight, length, number of conductors in cable, the name of Manufacturer and Purchaser's order or inspection number plainly and indelibly marked on a strong tag securely fastened to the cable and also stenciled on the outside of the reel.

21. *Notification.*

The completed cable is not to be shipped from place of manufacture until permission in writing has been received from the Purchaser. Should the cable on arrival at destination be found defective and not comply with the specifications, it will be returned to the Manufacturer who must pay all freight charges.

SPECIFICATIONS FOR LEAD COVERED CABLE FOR 2200 VOLTS.

1912.

1. *General.*

(a) Cable bought under these specifications will be used for ....current at twenty-two hundred (2200) volts and shall be ....feet in length.

(b) Workmanship and material shall be first-class and the best of their respective kinds and shall be in full accord with the best modern electrical and mechanical engineering practice.

2. *Cable.*

Cable shall consist of.....................conductors insulated with rubber and laid into cable with jute laterals to make round. The assembly to be taped and over the core thus formed a lead sheath shall be placed.

3. *Conductors.*

(a) Conductors shall be of the following sizes and numbers:

Number of conductors.	Approximate nearest size B. & S. gauge each conductor.	Number of strands.	Size of strands	Actual c.m. of conductors.
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....

(b) Conductors must be of soft-drawn, annealed copper wire, having a conductivity of not less than ninety-eight (98) per cent. of that of pure copper, Matthiessen's standard. Each wire forming a conductor must be continuous without weld, splice or joint throughout its length, must be uniform in cross section, free from flaws, scales and other imperfections and provided with a heavy uniform coating of tin.

4. *Rubber insulation.*

(a) The rubber insulation shall be made exclusively from pure Upriver, fine, dry Para rubber, of best quality, which has not previously been used in a rubber compound, solid waxy hydrocarbons, suitable mineral matter

4. *Rubber insulation.*—Continued.

and sulphur, properly and thoroughly vulcanized. Before being mixed with the other ingredients the rubber shall be thoroughly washed and dried.

(b) Each of the dry mineral matter ingredients shall be thoroughly dried and passed through a sieve having not less than one hundred (100) meshes to the inch for the whiting and sixty (60) meshes to the inch for the other ingredients before they are mixed together.

(c) The ingredients used in the mixture shall be of a quality here specified and within the proportional limits by weight given in the following table:

Ingredient.	Percentage by weight.	
	Minimum.	Maximum.
Upriver, fine, dry Para rubber	30.5	32.
Whiting	....	30.
Zinc oxide	28.	As desired
Litharge	1.	12.
Sulphur	1.5	2.5
Ozokerite or paraffin	2.	3.

Ingredient	Chemical composition.	Lowest grade acceptable.
Whiting	$CaCO_3$	96% pure
Zinc oxide	ZnO	Red seal

(d) The manufacturing processes shall be perfected to prevent, as far as practicable, excessive working of the rubber.

(e) The insulation must be homogeneous in character, tough, elastic, adhering to and be placed concentrically around the wire.

5. *Taping and filling.*

(a) The core of the cable must be made cylindrical in form and properly laid up with one (1) wire in each layer taped for a tracer. Cables of more than three (3) and less than seven (7) conductors shall be made up with a jute or sisal center. Each layer of core must have a spiral lay, each consecutive layer being spiraled in reverse direction from the preceding one. All interstices between insulated conductors must be thoroughly filled with dry jute to make round and covered with a layer of rubber insulating tape overlapping for one-third (1/3) its width.

(b) The tape shall be of closely woven cotton filled with rubber insulating compound and laid to make a smooth surface. The jute is to be well twisted and to be applied spirally.

6. *Sheath.*

A sheath, consisting of an alloy of lead and tin, containing not less than ninety-eight (98) per cent. pure lead and from one (1) to two (2) per cent. tin shall be applied over the assembled and taped conductors, and be of the following thicknesses for each of the different sizes of cables:

Diameter of cable over taping.	Thickness of lead sheath.
Under one (1) inch	3/32 inch.
One (1) to two (2) inches,	1/8 inch.
Over two (2) inches,	5/32 inch.

8. *Acceptance.*

The product of those concerns only will be accepted who have satisfied the Purchaser that the requirements of these specifications will be complied with. The decision as to the quality of the cable furnished and the acceptance of the same shall be made by the Purchaser.

9. *Tests.*

(a) The Manufacturer shall provide, at his factory, apparatus and other facilities needed for making the required physical and electrical tests.

(b) The Manufacturer shall give free access to the place of manufacture, and opportunity for inspecting and testing the product at all stages of manufacture to show that the required amount and quality of Para rubber and other ingredients are being used in the compound.

(c) Tests shall be made from samples taken from any part of any coil of wire and shall also be made upon the finished product before, and if desired, immediately after being delivered. If the requirements of these specifications are not met the cable will be rejected.

(d) At the option of the Purchaser, the wire after being tested shall not be made into a cable until an analysis of a sample has been made by a chemist, chosen by the Purchaser, and the results of such analysis as interpreted by the Purchaser, shall be sufficient ground for rejection should the wire or insulation not conform to the requirements of these specifications.

10. *Physical test of copper conductors.*

Each solid conductor must stand an elongation of twenty-five (25) per cent. of its length in ten (10) inches before breaking. It must be capable of being wrapped six (6) times about its diameter without showing signs of breakage.

11. *Conductivity test.*

The conductivity of the copper shall be determined by measuring the resistance of a length of wire and comparing with Matthiessen's standard of copper resistance.

12. *Tinning test.*

(a) Samples of wire shall be thoroughly cleaned with alcohol and immersed in hydrochloric acid of a specific gravity of 1.088 for one (1) minute. They shall then be rinsed in clear water and immersed in a solution of sodium sulphide of a specific gravity of 1.142 for thirty-two (32) seconds and again washed. This operation shall be repeated three (3) times and if the sample does not become blackened after the fourth immersion the tinning shall be regarded as satisfactory.

(b) The sodium sulphide solution must contain an excess of sulphur and should have sufficient strength to thoroughly blacken a piece of clean untinned copper wire in five (5) seconds.

15. *Physical tests of rubber insulation.*

(a) A sample of vulcanized rubber insulation not less than four (4) inches in length shall have marks placed upon it two (2) inches apart. The samples shall be stretched at the rate of three (3) inches per minute until the marks are six (6) inches apart and then at once released. One (1) minute after such release the marks shall not be over two and seven-sixteenths (2 7/16) inches apart. Samples shall then be stretched until the marks are nine (9) inches apart before breaking.

(b) The test to determine the tensile strength of the insulation shall be made upon as perfect a piece of vulcanized insulation as it is practicable to obtain from the wire being tested. The section of the test piece and the method of making the test shall be determined by the representative of the Purchaser, who shall as far as is consistent conform to the practices and requests of the Manufacturer.

(c) The tensile strength of the rubber insulation as shown by tests made on a carefully prepared sample shall be not less than twelve hundred (1200) pounds per square inch. The sample, for five (5) minutes before and as near as practicable during the test shall be maintained at a temperature of seventy (70) degrees Fahr.

(d) The specific gravity of the rubber insulation shall be not less than 1.85.

16. *Chemical tests of rubber insulation.*

The insulation shall show on analysis not less than thirty (30) nor more than thirty-three (33) per cent. of pure Upriver, fine, dry Para rubber, of best quality; not more than four (4) per cent. of waxy hydrocarbons, consisting of refined paraffin or pure ozokerite, not more than seven-tenths (0.7) of one per cent. of free sulphur, not more than two and five-tenths (2.5) per cent. total sulphur; freedom from all foreign matter and the mineral matter shall be such as will not have a deleterious effect on the insulation.

17. *Electrical tests of rubber insulation.*

(a) The thickness of the rubber insulation around each conductor (measured at the thinnest point), the minimum insulation resistance in megohms per mile when corrected to the standard temperature of sixty (60) degrees Fahr. and the dielectric strength shall conform to the following requirements:

B. & S. gauge.	Thickness of insulation. Inch.	Insulation resistance megohms per mile.	Test voltage alternating current.
0000	8/32	2400	10,000
000	8/32	2600	10,000
00	8/32	2900	10,000
0	8/32	3100	10,000
1	8/32	3300	10,000
2	8/32	3700	10,000
4	6/32	3400	8,000
6	6/32	4000	8,000
8	6/32	4600	8,000

(b) The coils of wire after being removed from the vulcanizer shall be kept for twenty-four (24) hours at the normal temperature of the factory storeroom before being placed in the testing bath.

(c) The test for insulation resistance must be made upon all wire after at least twelve (12) hours' submersion in water and while still immersed results shall be corrected to a water temperature of sixty (60) degrees Fahr. Tests must be made with the wire in coils, suitable for examination and before the application of braid or other covering with a well insulated battery and galvanometer, with not less than one hundred (100) volts and readings must be taken after one (1) minute's electrification. The

17. *Electrical tests of rubber insulation.*—Continued.

test voltage must be applied to the completed length of wire before the insulation test for a period of five (5) minutes, using alternating current from a generator and transformer of ample capacity.

(d) The insulation resistance at a given temperature shall be reduced to that at sixty (60) degrees Fahr. by dividing by the coefficient corresponding to that temperature. The tests shall be made at a temperature within the scope of this table.

Temperature degrees Fahr.	Coefficient shall be not greater than.	Temperature degrees Fahr.	Coefficient shall be not less than.
46	1.44	60	1.000
47	1.41	61	.974
48	1.37	62	.949
49	1.34	63	.925
50	1.30	64	.901
51	1.27	65	.878
52	1.24	66	.855
53	1.20	67	.833
54	1.17	68	.812
55	1.14	69	.791
56	1.11	70	.771
57	1.09	71	.751
58	1.06	72	.732
59	1.03	73	.713
60	1.00	74	.695
		75	.677

(e) The cable, when made up after assembling with lead covering, shall have the test voltage applied for five (5) minutes to each conductor, as follows:

1. Between conductors apply the full voltage test as required for separate wires.

2. Between each conductor and lead sheath apply a test voltage of but sixty (60) per cent. of that required for separate wires.

(f) The insulation resistance of each conductor shall be measured after test voltage has been applied to the completed cable and the resistance found shall be not less than that specified for separate conductors.

18. *Inspection.*

The Manufacturer shall notify the Purchaser when the manufacture of the wire and cable is to begin in order that inspection may be arranged for.

19. *Reel.*

Each cable shall be placed on a separate reel holding the full length of cable. Both ends of cable must be accessible for testing but be covered and protected from injury. The flanges of the reel shall be large enough to protect the cable in handling and rolling, in addition to which the reel must be properly cleated. The reel will become the property of the Purchaser but must be taken back by the Manufacturer upon request of the Purchaser.

20. *Marking.*

Each reel shall have the weight, length, number of conductors in cable, the name of Manufacturer and Purchaser's order or inspection number plainly and indelibly marked on a strong tag securely fastened to the cable and also stenciled on the outside of the reel.

21. *Notification.*

The completed cable is not to be shipped from place of manufacture until permission in writing has been received from the Purchaser. Should the cable on arrival at destination be found defective and not comply with the specifications, it will be returned to the Manufacturer who must pay all freight charges.

SPECIFICATIONS FOR UNDERGROUND BRAIDED CABLES FOR 660 VOLTS OR LESS.

1912.

1. *General.*

(a) Cable bought under these specifications will be used for ....current at ....volts and shall be ....feet in length.

(b) Workmanship and material shall be first-class and the best of their respective kinds and shall be in full accord with the best modern electrical and mechanical engineering practice.

2. *Cable.*

Cable shall consist of....................conductors insulated with rubber and laid into cable with jute laterals to make round. The assembly shall be taped and the core thus formed shall be wrapped with a closely-woven braid, as herein specified.

3. *Conductors.*

(a) Conductors shall be of the following sizes and numbers:

Number of conductors.	Approximate nearest size B. & S. gauge each conductor.	Number of strands.	Size of strands	Actual c.m. of conductors.
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....

(b) Conductors must be of soft-drawn, annealed copper wire, having a conductivity of not less than ninety-eight (98) per cent. of that of pure copper, Matthiessen's standard. Each wire forming a conductor must be continuous without weld, splice or joint throughout its length, must be uniform in cross section, free from flaws, scales and other imperfections and provided with a heavy uniform coating of tin.

4. *Rubber insulation.*

(a) The rubber insulation shall be made exclusively from pure Upriver, fine, dry Para rubber, of best quality, which has not previously been used in a rubber compound, solid waxy hydrocarbons, suitable mineral matter

4. *Rubber insulation.*—Continued.

and sulphur, properly and thoroughly vulcanized. Before being mixed with the other ingredients the rubber shall be thoroughly washed and dried.

(b) Each of the dry mineral matter ingredients shall be thoroughly dried and passed through a sieve having not less than one hundred (100) meshes to the inch for the whiting and sixty (60) meshes to the inch for the other ingredients before they are mixed together.

(c) The ingredients used in the mixture shall be of a quality here specified and within the proportional limits by weight given in the following table:

Ingredient.	Percentage by weight. Minimum.	Percentage by weight. Maximum.
Upriver, fine, dry Para rubber	30.5	32.
Whiting	....	30.
Zinc oxide	28.	As desired
Litharge	1.	12.
Sulphur	1.5	2.1
Ozokerite or paraffin	2.	3.

Ingredient	Chemical composition.	Lowest grade acceptable.
Whiting	$CaCO_3$	96% pure
Zinc oxide	ZnO	Red seal

(d) The manufacturing processes shall be perfected to prevent, as far as practicable, excessive working of the rubber.

(e) The insulation must be homogeneous in character, tough, elastic, adhering to and be placed concentrically around the wire.

5. *Taping, filling and braiding.*

(a) The core of the cable must be made cylindrical in form and properly laid up with one (1) wire in each layer taped for a tracer. Cables of more than three (3) and less than seven (7) conductors shall be made up with a jute or sisal center. Each layer of core must have a spiral lay, each consecutive layer being spiraled in reverse direction from the preceding one. Where the number of conductors is such as to leave an open space between conductors in any layer, a jute filling must be supplied in such open space to completely fill out the layer. Over the last layer of conductors shall be placed a layer of rubber insulating tape overlapping for one-third (1/3) its width. The tape shall be of closely woven cotton, filled

5. *Taping, filling and braiding.*—Continued.

with rubber insulating compound and laid to make a smooth surface.

(b) Over the taped core shall be placed one (1) layer of closely woven cotton braiding at least one-thirty-second (1/32) inch thick, saturated with a black, insulating weatherproof compound that shall be neither injuriously affected by nor have an injurious effect on the braid at a temperature of two hundred (200) degrees Fahr.

8. *Acceptance.*

The product of those concerns only will be accepted who have satisfied the Purchaser that the requirements of these specifications will be complied with. The decision as to the quality of the cable furnished and the acceptance of the same shall be made by the Purchaser.

9. *Tests.*

(a) The Manufacturer shall provide, at his factory, apparatus and other facilities needed for making the required physical and electrical tests.

(b) The Manufacturer shall give free access to the place of manufacture and opportunity for inspecting and testing the product at all stages of manufacture to show that the required amount and quality of Para rubber and other ingredients are being used in the compound.

(c) Tests shall be made from samples taken from any part of any coil and may also be made upon the finished product immediately after being delivered. If the requirements of these specifications are not met the wire will be rejected and the Manufacturer shall pay freight charges for the return of such material.

(d) At the option of the Purchaser, the wire after being tested, shall not be made into a cable until an analysis of a sample has been made by a chemist chosen by the Purchaser, and the results of such analysis as interpreted by the Purchaser, shall be sufficient ground for rejection should the wire or insulation not conform to the requirements of these specifications.

10. *Physical test of copper conductors.*

Each solid conductor must stand an elongation of twenty-five (25) per cent. of its length in ten (10) inches before breaking. It must be capable of being wrapped six (6) times about its diameter without showing signs of breakage.

11. *Conductivity test.*

The conductivity of the copper shall be determined by measuring the resistance of a length of wire and comparing with Matthiessen's standard of copper resistance.

12. *Tinning test.*

(a) Samples of wire shall be thoroughly cleaned with alcohol and immersed in hydrochloric acid of a specific gravity of 1.088 for one (1) minute. They shall then be rinsed in clear water and immersed in a solution of sodium sulphide of a specific gravity of 1.142 for thirty-two (32) seconds and again washed. This operation shall be repeated three (3) times and if the sample does not become blackened after the fourth immersion the tinning shall be regarded as satisfactory.

(b) The sodium sulphide solution must contain an excess of sulphur and should have sufficient strength to thoroughly blacken a piece of clean untinned copper wire in five (5) seconds.

15. *Physical tests of rubber insulation.*

(a) A sample of vulcanized rubber insulation not less than four (4) inches in length shall have marks placed upon it two (2) inches apart. The samples shall be stretched at the rate of three (3) inches per minute until the marks are six (6) inches apart and then at once released. One (1) minute after such release the marks shall not be over two and seven-sixteenths (2 7/16) inches apart. Samples shall then be stretched until the marks are nine (9) inches apart before breaking.

(b) The test to determine the tensile strength of the insulation shall be made upon as perfect a piece of vulcanized insulation as it is practicable to obtain from the wire being tested. The section of the test piece and the method of making the test shall be determined by the representative of the Purchaser, who shall as far as is consistent conform to the practices and requests of the Manufacturer.

(c) The tensile strength of the rubber insulation as shown by tests made on a carefully prepared sample shall be not less than twelve hundred (1200) pounds per square inch. The sample, for five (5) minutes before and as near as practicable during the test shall be maintained at a temperature of seventy (70) degrees Fahr.

(d) The specific gravity of the rubber insulation shall be not less than 1.85.

16. *Chemical tests of rubber insulation.*

The insulation shall show on analysis not less than thirty (30) nor more than thirty-three (33) per cent. of pure Upriver, fine, dry Para rubber, of best quality; not more than four (4) per cent. of waxy hydrocarbons, consisting of refined paraffin or pure ozokerite, not more than seven-tenths (0.7) of one per cent. of free sulphur, not more than two and five-tenths (2.5) per cent. total sulphur; freedom from all foreign matter and the mineral matter shall be such as will not have a deleterious effect on the insulation.

17. *Electrical tests of rubber insulation.*

(a) The thickness of the rubber insulation around each conductor (measured at the thinnest point), the minimum insulation resistance in megohms per mile when corrected to the standard temperature of sixty (60) degrees Fahr. and the dielectric strength shall conform to the following requirements:

B. & S. gauge.	Thickness of insulation. Inch.	Insulation resistance megohms per mile.	Test voltage alternating current.
4	3/32	1600	5000
6	3/32	1800	5000
8	3/32	2200	5000
9	5/64	2000	4000
10	5/64	2200	4000
12	5/64	2500	4000
14	5/64	2800	4000
16	2/32	2800	3000

(b) The coils of wire after being removed from the vulcanizer shall be kept for twenty-four (24) hours at the normal temperature of the factory storeroom before being placed in the testing bath.

(c) The test for insulation resistance must be made upon all wire after at least twelve (12) hours' submersion in water and while still immersed results shall be corrected to a water temperature of sixty (60) degrees Fahr. Tests must be made with the wire in coils, suitable for examination and before the application of braid or other covering with a well insulated battery and galvanometer, with not less than one hundred (100) volts and readings must be taken after one (1) minute's electrification. The test voltage must be applied to the completed length of

17. *Electrical tests of rubber insulation.*—Continued.

wire before the insulation test for a period of five (5) minutes, using alternating current from a generator and transformer of ample capacity.

(d) The insulation resistance at a given temperature shall be reduced to that at 60 degrees Fahr. by dividing by the coefficient corresponding to that temperature. The tests shall be made at a temperature within the scope of this table.

Temperature degrees Fahr.	Coefficient shall be not greater than.	Temperature degrees Fahr.	Coefficient shall be not less than.
46	1.44	60	1.000
47	1.41	61	.974
48	1.37	62	.949
49	1.34	63	.925
50	1.30	64	.901
51	1.27	65	.878
52	1.24	66	.855
53	1.20	67	.833
54	1.17	68	.812
55	1.14	69	.791
56	1.11	70	.771
57	1.09	71	.751
58	1.06	72	.732
59	1.03	73	.713
60	1.00	74	.695
		75	.677

(e) The cable, when made up after assembling and braiding, shall have the test voltage required for separate conductors, applied between conductors for five (5) minutes to each conductor.

(f) The insulation resistance of each conductor shall be measured after test voltage has been applied to the completed cable and the resistance found shall be not less than that specified for separate conductors.

18. *Inspection.*

The Manufacturer shall notify the Purchaser when the manufacture of the wire and cable is to begin in order that inspection may be arranged for.

19. *Reel.*

Each cable shall be placed on a separate reel holding the full length of cable. Both ends of cable must be accessible for testing but be covered and protected from

19. *Reel.*—Continued.

injury. The flanges of the reel shall be large enough to protect the cable in handling and rolling, in addition to which the reel must be properly cleated. The reel will become the property of the Purchaser but must be taken back by the Manufacturer upon request of the Purchaser.

20. *Marking.*

Each reel shall have the weight, length, number of conductors in cable, the name of Manufacturer and Purchaser's order or inspection number plainly and indelibly marked on a strong tag securely fastened to the cable and also stenciled on the outside of the reel.

21. *Notification.*

The completed cable is not to be shipped from place of manufacture until permission in writing has been received from the Purchaser. Should the cable on arrival at destination be found defective and not comply with the specifications, it will be returned to the Manufacturer who must pay all freight charges.

SPECIFICATIONS FOR COPPER OR TIN PLATED CHANNEL PINS.

1912.

1. *Purpose.*

Materials required under these specifications are to be used for fastening bonding wires and tap wires of a diameter of one hundred and sixty-five one-thousandths (.165) inch into a nine thirty-seconds (9/32) inch hole in the rail.

2. *Material.*

(a) Channel pins shall be made of steel or iron containing not less than fifteen one-hundredths (.15) per cent. nor more than twenty one-hundredths (.20) per cent. of combined carbon.

(b) The dimensions of channel pins shall be in accordance with Railway Signal Association drawing 1086.

3. *Malleability.*

Channel pins shall withstand being driven entirely through a hole nine thirty-seconds (9/32) of an inch in diameter, drilled in a piece of steel plate nine-sixteenths (9/16) of an inch thick, without showing a flaw or crack of any kind. In addition, the pins, after being driven in the steel plate half the length of the pin, shall stand bending at the large end ninety (90) degrees flat on the plate sidewise to the groove without cracking or showing a fracture of any kind.

4. *Plating.*

Pins shall be $\left\{\begin{array}{l}\text{tin}\\ \text{copper}\end{array}\right\}$ plated.

5. *Copper plating.*

Copper plating shall be done by the cyanide process heavily electro-plating the pins with a uniform homogeneous coating of copper. The plating shall average at least three-tenths (.3) pound of copper per one thousand (1000) pins.

6. *Tin plating.*

(a) Tin plating shall be done by either the hot or electric process in a manner similar to galvanizing. The plating shall be heavy and well done, even in thickness throughout, smooth and free from lumps.

(b) Tin plating on pins shall be not less than ninety-eight (98) per cent. pure tin.

7. *Method for testing for tin plating.*

Channel pins selected for this test shall be thoroughly cleaned with gasoline or varnish remover and then with soap and water. After rinsing the clean pins thoroughly with clear water they will be immersed in a hydrochloric acid solution for one (1) minute and, without wiping, dipped into a ferrocyanide solution; if a blue precipitate or discoloration takes place, it indicates the tin coating has been dissolved. The pins shall then be washed with clear water to free them from the ferrocyanide solution and the above operation repeated. Channel pins which have been plated in a satisfactory manner shall stand four (4) immersions of one (1) minute each in the hydrochloric acid solution without showing a blue precipitate or discoloration in the ferrocyanide solution.

8. *Solution for the tin plating test.*

(a) Potassium ferrocyanide solution: five (5) grams of the salt are dissolved in one thousand (1000) c.c. of distilled water.

(b) Hydrochloric acid solution shall have a specific gravity of 1.10, made by diluting hydrochloric acid, having a specific gravity of 1.20, with distilled water.

Note.—Instead of distilled water, hydrant water may be used if on testing with ferrocyanide it does not give a precipitate or discoloration.

9. *Gauging.*

Pins will be calibrated by the Purchaser and if more than five (5) per cent. of the samples taken from any bag are not of the proper dimensions, as shown on Railway Signal Association drawing 1086, then the whole bag will be rejected.

10. *Sampling.*

Twenty (20) or more samples will be taken at random from each bag of one thousand (1000) or fraction thereof, and five (5) will be used for making the test for coating.

11. *Packages.*

Pins shall be put in strong canvas bags containing one
{ one thousand (1000) pins }
{ five hundred (500) pins }.

12. *Markings.*

Each bag shall be plainly marked or tagged to show the number and kind of pins contained therein, the Purchaser's order number and requisition number under which furnished, name of the Consignor and the address of the Consignee.

13. *Inspection.*

Material will usually be inspected and tested at the place of manufacture. The Manufacturer shall notify the Purchaser at least two (2) days before the pins will be ready for shipment and shall furnish, free of cost to the Purchaser, testing apparatus and assistance necessary to make a satisfactory inspection and test. If the Purchaser prefers to inspect and test pins after they reach destination, the Manufacturer will be notified by him to ship them with the understanding that if they fail to meet the requirements of this specification they will be rejected.

14. *Acceptance.*

If, after an inspection of the entire shipment in accordance with the tests herein enumerated, these specifications are met, the material will be accepted. If these specifications are not met, the material will be returned to the Manufacturer, who shall pay all freight charges.

SPECIFICATIONS FOR FIBRE CONDUIT, THREE INCHES IN DIAMETER AND ONE-FOURTH INCH WALL.

1912.

1. *Purpose.*

The intent of these specifications is to provide for the furnishing of three (3) inch fibre conduit with one-fourth (1/4) inch wall for the protection of rubber insulated signal wires and cables used in interlocking and signal installations.

2. *Properties.*

(a) The wall of the conduit shall be not less than one-fourth (1/4) inch thick; the inner surface of which shall be free from dents or obstructions and from flaky areas or any considerable excess of the impregnating compound.

(b) The bore shall be straight and shall not vary in cross sections more than one-sixteenth (1/16) inch from a true circle.

(c) Short lengths up to fifteen (15) per cent. of the shipment may be less than five (5) feet but not less than three (3) feet in length.

3. *Joints, fittings and bends.*

(a) Mortise and tenon of the socket joints shall be a close fit and not less than three-eighths (3/8) inch long and slightly tapered.

(b) Sleeve and ends of sleeve type joint shall be turned to a close fit.

(c) Sleeve and ends of drive joint conduit shall be finished with a taper and make a close fit.

(d) Screw thread cut on ends of each length of conduit and in the couplings and fittings of screw joint type shall be four (4) threads to the inch, U. S. Standard. The ends shall be squared and faced so as to meet all around when screwed into the couplings or fittings. Couplings and fittings of screw joint type shall have a close fit but must allow screwing on by hand.

(e) Fittings and bends shall be made throughout of the same material as is used in the conduit and shall possess the same mechanical strength and insulating qualities.

4. *Tests.*

(a) The material shall not be affected by acids or alkalies which may be present in the ground and shall itself be free from all substances which might injuriously affect rubber covered wire or lead sheath cable.

4. *Tests.*—Continued.

(b) Walls shall be compact and shall not disintegrate when heated to a temperature of two hundred and twelve (212) degrees Fahr.

(c) The bore shall be uniform as gauged by the ability to pass a mandrel thirty-six (36) inches in length of three-sixteenths (3/16) inch less diameter than the normal size of the conduit.

(d) The wall of the conduit after being immersed in pure water at seventy (70) degrees Fahr. for forty-eight (48) hours shall not puncture when alternating current at a pressure of twenty thousand (20,000) volts is applied by mercury contacts to each side of the wall at adjacent points.

(e) A sample of conduit at seventy (70) degrees Fahr. resting on supports twenty-six (26) inches apart shall deflect less than one-fourth (¼) inch when a weight of two hundred (200) pounds is suspended half way between the supports.

(f) A six (6) inch sample of conduit at seventy (70) degrees Fahr. shall not be crushed when placed between two (2) flat surfaces under a pressure of two hundred and forty (240) pounds.

(g) A six (6) inch sample of conduit shall be thoroughly dried at a temperature of one hundred and ten (110) degrees Fahr. for four (4) hours, then weighed and after immersion for forty-eight (48) hours in pure water at seventy (70) degrees Fahr. shall show less than two (2) per cent. increase in weight due to absorption of water.

(h) The Manufacturer shall provide, at his works, if required by the Purchaser, all apparatus and other facilities needed for making the required tests, and shall give the Purchaser's representative an opportunity to test at all necessary times. Tests may also be made after delivery, and the conduit will be rejected if it fails to meet the requirements of the specifications. The Manufacturer shall pay all freight charges on rejected conduit.

5. *Marking.*

Conduit shipped in less than carload lots shall have the name of the Manufacturer, the Purchaser's order and Inspection number and the shipping address plainly and indelibly marked on a tag securely fastened to ten (10) per cent. of the pieces in the shipment.

SPECIFICATIONS FOR VITRIFIED CLAY CONDUIT.

1912.

1. *Purpose.*

The intent of these specifications is to provide for the furnishing of round or square bore single duct, and square bore two (2), three (3), four (4), six (6), or nine (9) duct multiple vitrified clay conduit for wires and cables.

2. *Dimensions.*

(a) The dimensions of all pieces of conduit in any lot shall conform to the required lengths shown below, with an allowable variation of one-half (1/2) inch either way.

1. Single duct conduit, eighteen (18) inches.
2. Two duct conduit, twenty-four (24) inches.
3. Three duct conduit, twenty-four (24) inches.
4. Four duct conduit, thirty-six (36) inches.
5. Six duct conduit, thirty-six (36) inches.
6. Nine duct conduit, thirty-six (36) inches.

(b) Short lengths shall be approximately six (6), nine (9), twelve (12), eighteen (18), twenty-four (24) and thirty (30) inches.

(c) Duct holes shall be not more than three and one-half (3 1/2) inches nor less than three and one-fourth (3 1/4) inches in diameter or between opposite walls.

(d) The minimum thickness of the walls of single and multiple conduit shall be as follows:

Type.	Wall thickness.	
	Outer.	Inner.
Single duct conduit	7/16″	.....
Multiple conduit	5/8″	7/16″

(e) Multiple duct conduit shall be provided with at least two (2) dowel pin holes at each end. The dowel pin holes shall be not more than fifteen thirty-seconds (15/32) of an inch, nor less than eleven thirty-seconds (11/32) of an inch in diameter, and shall be not less than one and three-fourths (1 3/4) inches deep, and shall be located in the centre of the intersection of the walls, that when two (2) sections of conduit are assembled on the pins, one (1) piece being fixed and the other placed in all

2. *Dimensions.*—Continued.

possible symmetrical positions, a mandrel twelve (12) inches long and three (3) inches square may be drawn through the assembled sections.

3. *Workmanship.*

(a) The ends of each piece shall be perpendicular to its sides and shall be smooth and free from projections. In the case of square conduit the interior corners of duct holes and the exterior edges of the conduit, excluding the ends, shall be slightly rounded. All duct holes shall be beveled at their ends and holes in single conduit shall be well centered.

(b) Conduit shall not contain through cracks at the ends exceeding one-half (1/2) inch in length.

(c) The outer walls of conduit shall be free from transverse through cracks.

(d) Conduit shall be free from air checks.

(e) Conduit having chipped ends will not be accepted if the fracture extends deeper than the beveling.

(f) The interior walls of single conduit shall be free from rough or sharp blisters or other projections and from smooth, rounded blisters which project more than one-sixteenth (1/16) of an inch above the surface of the wall.

(g) The interior surface of all multiple ducts shall be free from rough or sharp blisters, and shall not contain smooth rounded blisters or other projections more than one-eighth (1/8) of an inch in the rounded corners nor more than one-sixteenth (1/16) of an inch for a distance of two and one-half (2 1/2) inches in the center of the sides.

(h) Blisters or other projections on the outer surfaces of single or multiple conduit shall not project more than three-sixteenths (3/16) of an inch. Smooth salt drip projecting not more than one-eighth (1/8) inch above the outer surface will not be classed as an objectionable form of unbroken blister.

(i) Recesses in the walls of single or multiple conduit caused by broken blisters or other defects shall not decrease the thickness of the walls by more than three-sixteenths (3/16) of an inch. When on the interior walls, the edges of the recesses shall be smoothed so as to offer no projecting edges.

3. *Workmanship.*—Continued.

(j) The outer walls of single conduit shall be scarified with two (2) sets of three (3) combings each, running lengthwise on the conduit and placed adjacent to the corners.

(k) The outer walls of multiple conduit shall be scarified transversely or otherwise, suitably roughened for at least two (2) inches at each end.

(l) Inside walls of at least seventy-five (75) per cent. of the pieces in any lot of conduit shall be thoroughly glazed. Inside walls not thoroughly glazed shall be smooth and the conduit shall be thoroughly vitrified.

4. *Tests.* (a) Material offered for inspection under these specifications shall be factory run, from which no conduit of superior quality has been removed.

(b) A straight edge laid lengthwise on the concave side or sides of a three (3) foot section of conduit may show on one (1) side an offset of not more than three-eighths (3/8) of an inch; provided, that if the section contains another concave side the offset of the second concave side shall not be greater than one-eighth (1/8) inch. The allowable offset in conduit shorter than three (3) feet in length shall be proportional to the limits allowed for three (3) foot lengths. Seventy (70) per cent. of the number of pieces of conduit accepted from any lot offered for inspection shall be free from bends and the remainder shall not contain bends greater than the limits specified above.

(c) A section of finished conduit free from scarifications weighing approximately three (3) pounds broken so as to leave all edges unglazed and clean, after being thoroughly dried and then completely immersed in pure water at a temperature of seventy (70) degrees Fahr. for twenty-four (24) hours shall show less than five (5) per cent. increase in weight due to absorption of water.

(d) The finished conduit shall be free from soluble alkalies, as determined by testing with red litmus paper.

(e) The Manufacturer shall provide, at his works, if required by the Purchaser, all apparatus and other facilities needed for making the required tests, and shall give the Purchaser's representative an opportunity to test at all necessary times. Tests may also be made after delivery, and the conduit will be rejected if it fails to meet

4. *Tests.*—Continued.

the requirements of the specifications. The Manufacturer shall pay all freight charges on rejected conduit.

5. *Marking.*

Conduit shipped in less than car load lots shall have the name of the Manufacturer, the Purchaser's order, inspection number and the shipping address plainly marked on a tag securely fastened to ten (10) per cent. of the pieces in the shipment.

6. *Packing.*

Multiple duct conduit, when shipped in cars, shall be so packed that the ends and each layer shall be separated. The ends of all conduit, at the center of the car, shall be firmly braced to prevent movement of the conduit during shipment.

SPECIFICATIONS FOR WOOD CROSSARMS.

1912.

1. *Purpose.*

The material required under these specifications is to be used for carrying steel crossarm pins supporting insulators to which aerial line wires are attached.

2. *Material.*

Crossarms shall be made of Cypress* or Douglas Fir.†.

3. *Dimensions.*

Dimensions of crossarms shall be in accordance with Railway Signal Association drawing 1089.

4. ***Workmanship.***

Workmanship shall be first-class in all particulars. The boring for the pin and bolt holes shall be smooth and straight, and the surface of the arm shall not be splintered by augur or machine bit.

5. ***Quality.***

(a) Cypress crossarms shall be free from pith heart and sapwood.

(b) Douglas Fir crossarms may contain sapwood, provided it is clear and does not form over fifteen (15) per cent. of the cross section of the crossarm. Crossarms shall be cut so that the sapwood shall be on the top or sides.

(c) Crossarms shall be reasonably straight-grained. The grain shall not depart from paralellism to any edge of the crossarm by an amount greater than one (1) inch to three (3) feet length of crossarm.

(d) Crossarms shall be out of wind.

(e) Crossarms shall be free from pitch pockets exceeding five (5) inches in length and one-fourth (1/4) of an inch in width, and from all pitch pockets which enter the pin or bolt holes on the top or sides of the crossarms.

(f) Crossarms shall be free from loose or unsound knots.

---

*Cypress shall be understood to mean the timber known as Red Cypress.

†Douglas Fir shall be understood to mean the timber known likewise as Yellow Fir, Red Fir, Western Fir, Washington Fir, Oregon or Puget Sound Fir or Pine, North and West Coast Fir.

5. *Quality.*—Continued.

(g) Ten (10) pin crossarms shall be free from knots at the fourth, fifth, sixth and seventh pin holes and at the bolt holes; eight (8) pin crossarms shall be free from knots at the third, fourth, fifth and sixth pin holes and at the bolt holes; six (6) pin and four (4) pin crossarms shall be free from knots at the two middle pin holes and at the bolt holes.

(h) Ten (10) pin crossarms may have sound knots not over three-fourths (3/4) of an inch in diameter between the fourth and seventh pin holes; eight (8) pin crossarms may have sound knots not over three-fourths (3/4) of an inch in diameter between the third and sixth pin holes; and six (6) pin and four (4) pin crossarms may have sound knots not over three-fourths (3/4) of an inch in diameter between the middle pin holes.

(i) Sound knots larger than three-fourths (3/4) of an inch will not be considered a defect under the following conditions: They shall be outside the fourth and seventh pin holes in ten (10) pin crossarms, the third and sixth pin holes in eight (8) pin arms and the middle pins in six (6) and four (4) pin arms; they shall not exceed three-fourths (3/4) of an inch in diameter near the above-mentioned pin holes, but may gradually increase in size to one-half the cross-section of the arm at the ends.

(j) Crossarms shall be free from wane.

(k) Crossarms shall be free from through shakes and from other shakes or checks exceeding three (3) inches in length.

(l) Crossarms will be rejected that are bent in more than one direction or edgewise. A straight edge laid lengthwise the full length of the crossarm on the concave side, shall not show an offset greater than one (1) inch on a ten (10) pin or eight (8) pin arm, or greater than three-fourths (3/4) of an inch on a six (6) pin arm, or greater than one-half (1/2) of an inch on a four (4) pin arm.

(m) Crossarms shall be free from loose hearts, red hearts, rot, dote or worm holes.

6. *Inspection.*

Crossarms will usually be inspected at the mill. If, however, the Purchaser prefers, the Manufacturer will be notified to ship them subject to inspection at destination,

7. *Marking.*

Twelve crossarms in each shipment shall be plainly marked or tagged to show the number of crossarms contained in the shipment, the Purchaser's order and requisition number under which furnished, the name of the Consignor and the address of the Consignee.

8. *Acceptance.*

If, after on inspection of the entire shipment, the specifications are met, the material will be accepted. If the specifications are not met, the material will be returned and the Manufacturer shall pay all freight charges.

SPECIFICATIONS FOR CROSSARM BRACES AND HEEL AND TOE BOLTS.

1912.

1. *Purpose.*

The material required under these specifications is to be used for fastening crossarms to line poles.

2. *Material.*

(a) Crossarm braces shall be made from rolled steel containing from thirty-five one-thousandths (.035) to fifty one-thousandths (.050) of carbon.

(b) Heel and toe bolts shall be made from open hearth steel containing twelve one-thousandths (.012) to sixteen one-thousandths (.016) of carbon.

(c) One heel and two toe bolts shall be furnished with each pair of braces.

3. *Dimensions.*

Dimensions of crossarm braces and heel and toe bolts shall be in accordance with Railway Signal Association drawing 1219.

4. *Workmanship.*

(a) Crossarm braces shall be straight and shall have smooth surfaces and edges, and holes shall be punched smooth and in the center of the brace.

(b) Heel and toe bolts shall be free from badly formed or otherwise defective heads and have a clean thread and sharp point.

5. *Galvanizing.*

(a) Braces and bolts $\left\{\begin{matrix}\text{shall}\\\text{shall not}\end{matrix}\right\}$ be galvanized.

(b) When galvanized, the galvanizing shall comply with the specifications of the Railway Signal Association for "Galvanizing for iron or steel."

6. *Sampling.*

For each test, one brace or bolt will be selected at random from each one hundred (100) or fraction thereof.

7. *Inspection.*

Material will usually be inspected and tested at the place of manufacture. The Manufacturer will notify the Purchaser, at least two (2) days beforehand, when the braces and bolts will be ready for shipment, and shall furnish free of cost to the Purchaser, apparatus and assistance neces-

7. *Inspection.*—Continued.

sary to make the inspection and tests. If the Purchaser prefers, Manufacturer will be notified to ship subject to inspection at destination.

8. *Packing.*

(a) Crossarm braces shall be securely tied with wire in bundles of ten (10) pairs each.

(b) Heel and toe bolts shall be securely packed in strong boxes in such quantities as to insure safe handling.

9. *Marking.*

Each bundle of braces and each package of heel and toe bolts shall be plainly marked or tagged showing the number of pieces contained therein, the Purchaser's order and requisition numbers under which furnished, the name of the Consignor and the address of the Consignee.

10. *Acceptance.*

If, after an inspection of the entire shipment, the specifications are met, the material will be accepted. If the specifications are not met, the material will be returned to the Manufacturer, who shall pay all freight charges.

SPECIFICATIONS FOR STEEL CROSSARM PINS.

1912.

1. *Purpose.*

The material required under these specifications is to be used for supporting insulators, to which aerial lines are attached.

2. *Material.*

Material required for a complete pin consists of one (1) cap, one (1) spindle, one (1) washer and one (1) nut assembled, in accordance with Railway Signal Association drawings 1165 and 1166.

3. *Caps.* (a) Caps shall be made of sound split oak, straight grained and free from knots, cracks, checks, sap-wood, brash-wood and worm holes, and the grain of the wood shall be practically parallel to the axis of the cap.

(b) Caps must be thoroughly air-dried and before being fitted to the spindles shall be boiled in paraffin until the maximum amount possible of paraffin has been absorbed.

(c) Caps shall be made so that they will fit, without a perceptible change in the taper or without varying from within the maximum and minimum limits, the gauge shown on Railway Signal Association drawing 1167.

(d) Caps shall fit tight on the steel spindles.

(e) Threads on caps shall be smooth, uniform in pitch, and such that a standard insulator can be readily screwed on the pin until the end of the cap touches the top of the insulator, in which position there shall be no perceptible rocking or play of the insulator on the pin.

4. *Spindles.*

(a) Spindles shall be made of a good quality of steel.

(b) Spindles shall have a smooth finish and shall be free from injurious flaws and other defects.

(c) The threads shall be full, clear and concentric with the axis of the spindles.

5. *Nuts.* (a) Nuts shall be made from a good quality of steel.

(b) Nuts shall be symmetrically formed and with holes centrally located.

(c) The axis of the threads shall be reasonably perpendicular to the face of the nut. The nuts shall fit the threads of the spindles, being neither so loose that a noticeable amount of play or rocking can be felt between the nut and the spindle thread, nor so tight that the nut cannot be run one-half (1/2) the length of the thread without undue forcing with the fingers.

6. *Washers.*

Washers shall be made of a good quality of steel and free from injurious flaws and defects.

7. *Strain test.*

Standard pins.

(a) When held rigidly by the shank, the standard pin shall withstand a strain of one thousand (1000) pounds, applied at right angles to the upper part of the pin at a distance of three and one-fourth (3 1/4) inches from the shoulder, without fracture and without deflecting more than one (1) inch at the point of application of the load. The reading for the deflection shall begin after an initial strain of one hundred (100) pounds has been applied.

(b) The load shall be applied by means of a wire looped around the groove of a standard insulator, fitting tightly on the pin.

Terminal pins.

Terminal pins shall be tested in the same manner as standard pins except the load in each case shall be seventeen hundred (1700) pounds.

8. *Galvanizing.*

(a) Pins and washers $\left\{\begin{array}{l}\text{shall}\\ \text{shall not}\end{array}\right\}$ be galvanized.

(b) When galvanized, galvanizing shall comply with the specifications of the Railway Signal Association for "Galvanizing for iron or steel."

9. *Packing.*

Pins shall be packed so as to be protected from injury and loss during shipment.

10. *Marking.*

Each package shall be plainly marked showing the number and kind of pins contained therein, the Purchaser's order and requisition numbers, the name of the Consignor and the address of the Consignee.

11. *Sampling.*

For the strain and galvanizing tests one (1) pin will be taken at random from each lot of one hundred (100) pins or fraction thereof for each test.

12. *Inspection.*

Material will usually be inspected and tested at the works where it is made. Manufacturer will notify the Purchaser at least two (2) days before the pins will be ready for shipment and shall furnish, free of cost to the Purchaser, apparatus and assistance necessary to make the inspection and tests. If the Purchaser prefers, the Manufacturer will be notified to ship subject to inspection at destination.

13. *Acceptance.*

If, after an inspection of the entire shipment, the specifications are met, the material will be accepted. If the specifications are not met, the material will be returned and the Manufacturer shall pay all freight charges.

SPECIFICATIONS FOR CROSSARM THROUGH BOLTS AND DOUBLE ARM BOLTS.

1912.

1. *Purpose.*

The material required under these specifications are for fastening crossarms to line poles.

2. *Material.*

Bolts shall be made from $\left\{\begin{array}{l}\text{wrought iron}\\ \text{mild steel}\end{array}\right\}$ and shall be furnished with $\left\{\begin{array}{l}\text{cut}\\ \text{rolled}\end{array}\right\}$ threads.

3. *Dimensions.*

Dimensions shall be according to Railway Signal Association drawing 1220.

4. *Workmanship.*

(a) Bolts shall be free from badly formed or otherwise defective heads. The ends of bolts shall be rounded or champfered. The threads shall be full, clean and concentric with the axis of the bolts.

(b) Nuts shall be symmetrically formed and holes centrally located. The axis of threads shall be perpendicular, or nearly so, to the face of the nut. The nuts shall fit the threads of bolts, being neither so loose that a noticeable amount of play or rocking can be felt between the nut and bolt thread, nor so tight that the nut cannot be run the entire length of thread without undue forcing with the fingers.

5. *Mechanical requirements.*

(a) Bolts shall withstand a breaking weight of not less than ten thousand (10,000) pounds, and the threads shall not strip under that load. The load shall be applied at the head of the bolt and at the nut, with at least two (2) end threads extending beyond the nut.

(b) When held rigidly by one end, the bolts shall withstand bending through an angle of ninety (90) degrees, about a diameter equal to the diameter of the bolt, without fracture of the iron or steel on the outside of the bend.

6. *Galvanizing.*

(a) Bolts and nuts $\left\{\begin{array}{l}\text{shall}\\ \text{shall not}\end{array}\right\}$ be galvanized.

(b) When galvanized, the galvanizing shall comply with the specifications of the Railway Signal Association for "Galvanizing for iron or steel."

7. *Sampling.*

For the strain, bending and galvanizing tests, one bolt will be selected at random from each one hundred (100) or a fraction thereof for each test.

8. *Inspection.*

Material will usually be inspected and tested at the place of manufacture. The Manufacturer will notify the Purchaser, at least two (2) days beforehand, when the bolts will be ready for shipment and shall furnish, free of cost to the Purchaser, apparatus and assistance necessary to make the inspection and tests. If the Purchaser prefers to inspect and test this material at destination, the Manufacturer will be notified to ship subject to inspection at destination.

9. *Packing.*

Bolts shall be packed in strong boxes, bound on the ends with one-half (1/2) inch hoop iron, in such numbers that they may be readily handled without injury to the box. Each through bolt shall have its nut screwed on a full nut. Each double arm bolt shall have its four nuts screwed on as shown on Railway Signal Association drawing 1220.

10. *Marking.*

Each box shall be plainly marked or tagged to show the number and kind of bolts contained therein, the Purchaser's order and requisition numbers under which furnished, the name of the Consignor and the address of the Consignee.

11. *Acceptance.*

If, after an inspection of the entire shipment, these specifications are met, the material will be accepted. If these specifications are not met, the material will be returned and the Manufacturer shall pay all freight charges incurred.

Definitions for Technical Terms.

Drawbridges.

PROTECTION BY ELEC.-PNEU. INTERLOCKING.

PROTECTION BY MECHANICAL INTERLOCKING.

Drawings.

STANDARD DESIGNS FOR SIGNAL APPARATUS.

PROTECTION FOR DRAWBRIDGES BY ELECTRO-PNEUMATIC INTERLOCKING.

1912.

Preliminary locking arrangement shall be provided for each of the following purposes before proceed signals can be displayed:

(a) To prevent application of power for the purpose of operating the bridge, or anything in connection with the bridge.

(b) To insure that the bridge is in proper alignment and that the bridge surfacing devices are in their proper positions.

(c) To lock each rail in proper position for train movement.

Note.—The locking recommended in the preceding paragraphs will compel the movements to proceed in the following order:

1. *Opening draw span where derails and smashboards are not used.**
   (a) Display stop signals.
   (b) Unlock rails.
   (c) Withdraw rail connections.
   (d) Withdraw bridge alignment lock.
   (e) Release bridge machinery.

2. *Closing draw span where derails and smashboards are not used.**
   (a) Lock bridge machinery.
   (b) Insert bridge alignment lock.
   (c) Drive rail connections.
   (d) Lock rails.

3. *Opening draw span where derails or smashboards are used.**
   (a) Display stop signals.
   (b) Unlock and open derails or set smashboards in stop position.
   (c) Unlock rails.
   (d) Withdraw rail connections.
   (e) Withdraw bridge alignment lock.
   (f) Release bridge machinery.

4. *Closing draw span where derails or smashboards are used.**
   (a) Lock bridge machinery.
   (b) Insert bridge alignment lock.
   (c) Drive rail connections.
   (d) Lock rails.
   (e) Close and lock derails, or set smashboards in proceed position.

---

*NOTE.—See explanatory notes.

5. *Rail locks.*

Each rail lock shall be located as near the end of the draw span as practicable.

6. *Electric bridge couplers.*

When electric bridge couplers are used to carry electric circuits on to the draw span:

1. The method of operation will depend on the location of the interlocking machine with respect to the draw span.

2. If the interlocking machine is on the draw span, the coupler will be so arranged as to be opened with the movement that releases the bridge machinery.

3. If the interlocking machine is not on the draw span the bridge coupler shall be so arranged as to be opened with the movement that withdraws the wedges.

7. *Air line.*

Air line may be carried on the draw span by means of flexible hose connections and standard train air hose couplers.

EXPLANATORY NOTES.

1. *Opening draw span where derails and smashboards ARE NOT used.*

Movements (b), (d) and (e) may be accomplished by one (1) lever.

Movement (c) will be performed only when rail connections are operated from interlocking machine.

2. *Closing draw span where derails and smashboards ARE NOT used.*

Movements (a), (b) and (d) may be accomplished by one (1) lever.

Movement (c) will be performed only when rail connections are operated from interlocking machine.

3. *Opening draw span where derails or smashboards ARE used.*

Movements (c), (e) and (f) may be accomplished by one (1) lever.

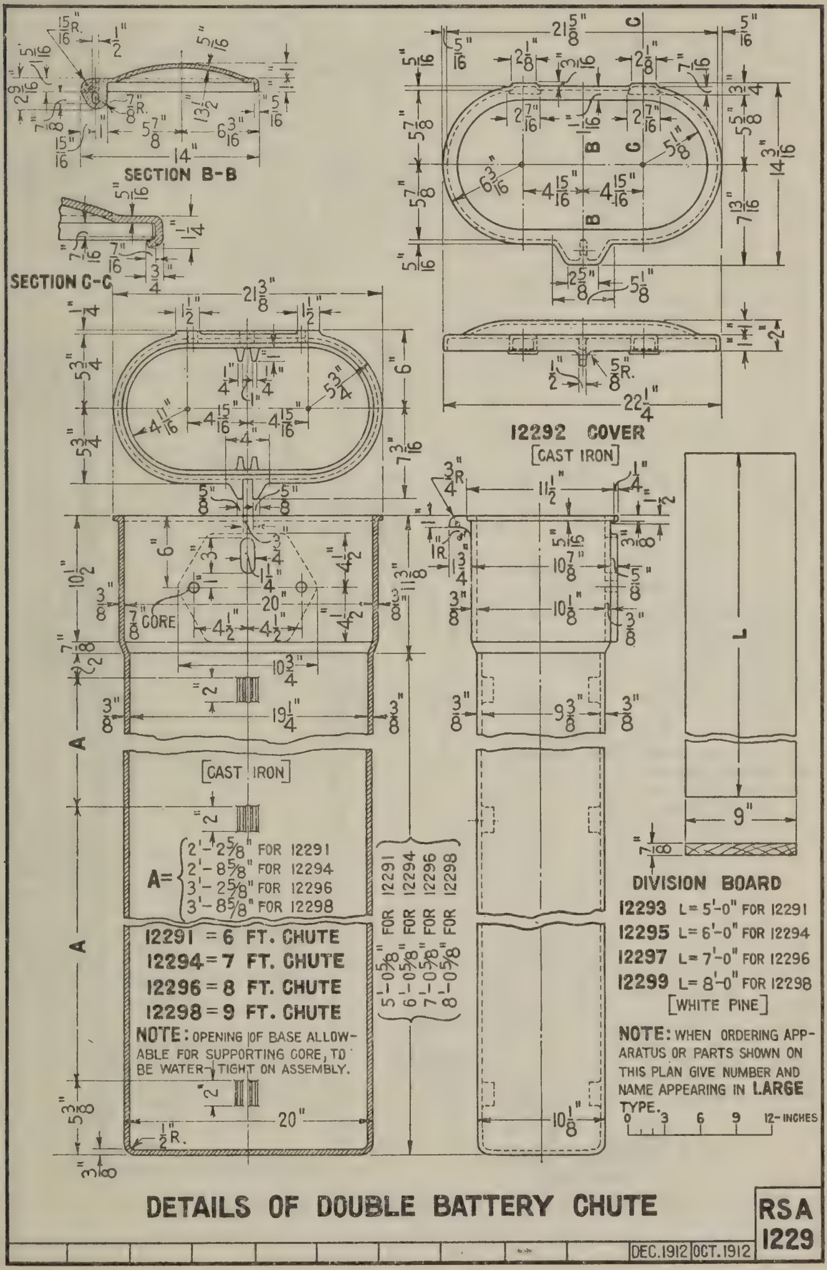
Movement (d) will be performed only when rail connections are operated from interlocking machine.

4. *Closing draw span where derails or smashboards ARE used.*

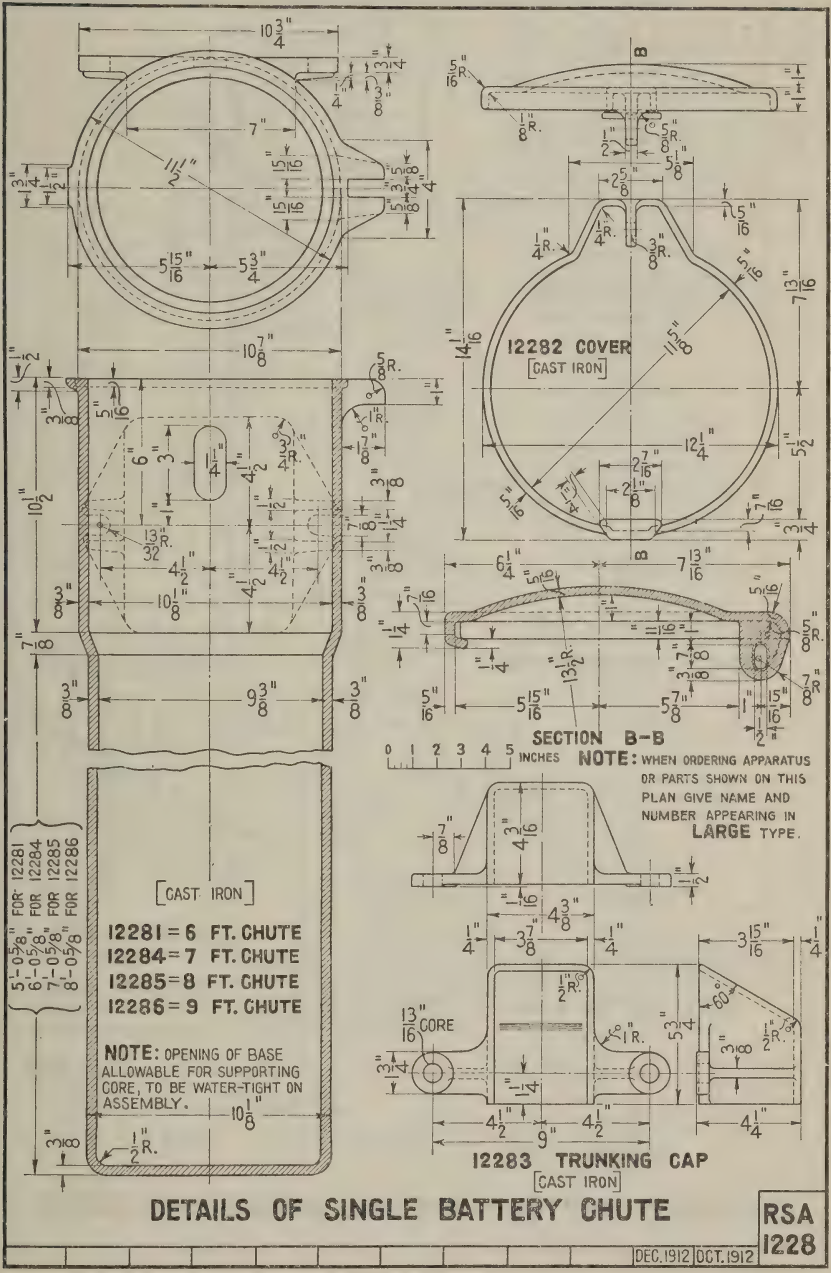
Movements (b) and (d) may be accomplished by one (1) lever.

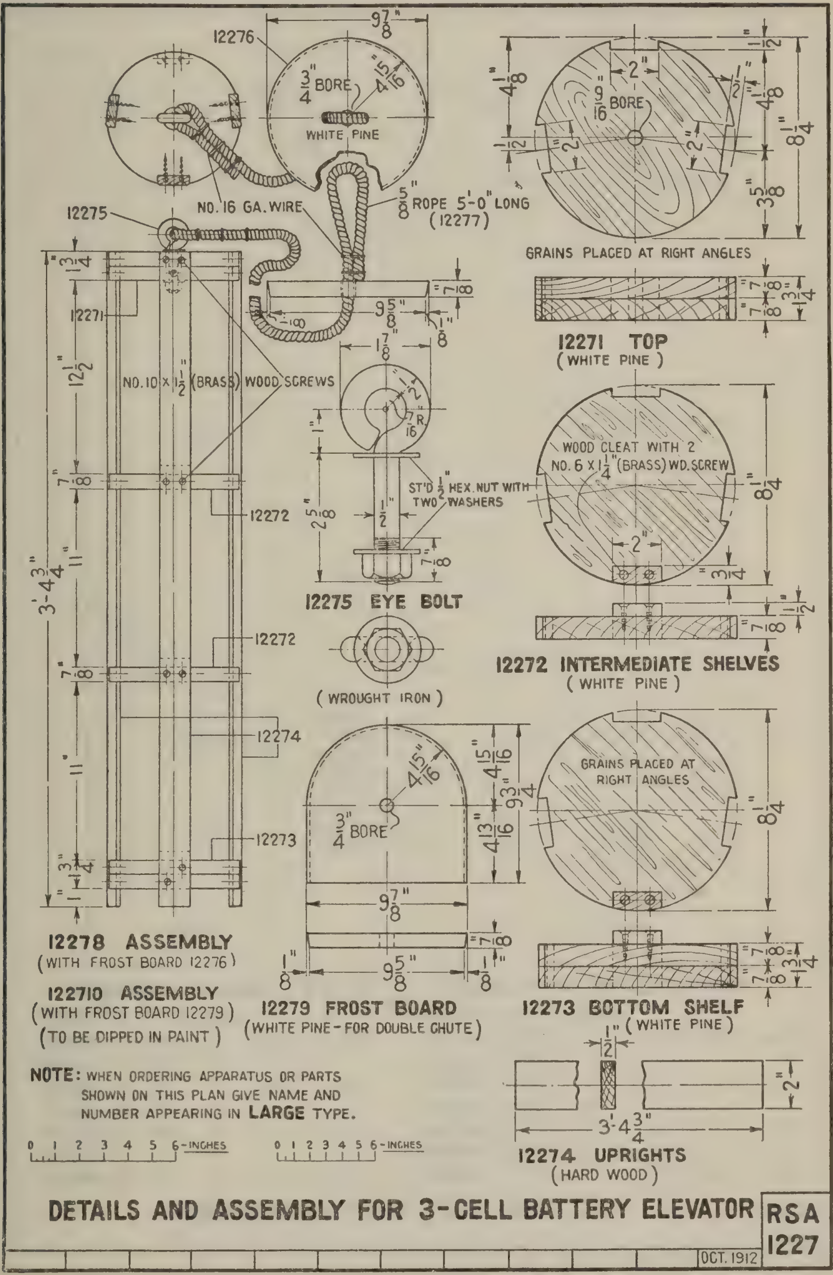
Movement (c) will be performed only when rail connections are operated from interlocking machine.

Battery Chute.
Double.
Details.


SECTION B-B
SECTION C-C
12292 COVER
[CAST IRON]
[CAST IRON]
A= 2'-2⅝" FOR 12291
2'-8⅝" FOR 12294
3'-2⅝" FOR 12296
3'-8⅝" FOR 12298
12291 = 6 FT. CHUTE
12294 = 7 FT. CHUTE
12296 = 8 FT. CHUTE
12298 = 9 FT. CHUTE
NOTE: OPENING OF BASE ALLOWABLE FOR SUPPORTING CORE, TO BE WATER-TIGHT ON ASSEMBLY.
5'-0⅝" FOR 12291
6'-0⅝" FOR 12294
7'-0⅝" FOR 12296
8'-0⅝" FOR 12298
CORE
DIVISION BOARD
12293 L= 5'-0" FOR 12291
12295 L= 6'-0" FOR 12294
12297 L= 7'-0" FOR 12296
12299 L= 8'-0" FOR 12298
[WHITE PINE]
NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN LARGE TYPE.
0 3 6 9 12-INCHES
DETAILS OF DOUBLE BATTERY CHUTE
DEC.1912
OCT.1912
RSA
1229

Battery Chute.
Single.
Three Cells.
Details.


12282 COVER
[CAST IRON]
SECTION B-B
0 1 2 3 4 5 INCHES
NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NAME AND NUMBER APPEARING IN LARGE TYPE.
[CAST IRON]
12281 = 6 FT. CHUTE
12284 = 7 FT. CHUTE
12285 = 8 FT. CHUTE
12286 = 9 FT. CHUTE
5'-0⅝" FOR 12281
6'-0⅝" FOR 12284
7'-0⅝" FOR 12285
8'-0⅝" FOR 12286
NOTE: OPENING OF BASE ALLOWABLE FOR SUPPORTING CORE, TO BE WATER-TIGHT ON ASSEMBLY.
13/16" CORE
12283 TRUNKING CAP
[CAST IRON]
DETAILS OF SINGLE BATTERY CHUTE
RSA 1228
DEC. 1912 OCT. 1912
B
B


12276
9 7/8"
3/4" BORE
4 15/16"
WHITE PINE
NO. 16 GA. WIRE
5/8" ROPE 5'-0" LONG
(12277)
12275
1 3/4"
12271
12 1/2"
NO. 10 X 1 1/2" (BRASS) WOOD SCREWS
7/8"
12272
3'-4 3/4"
11"
12274
12273
3/4"
1"
9 5/8"
1/8"
1 7/8"
1/2"
7/16 R.
ST'D 1/2" HEX. NUT WITH TWO WASHERS
2 5/8"
4 1/8"
2"
9/16 BORE
1/2"
2"
3 5/8"
8 1/4"
GRAINS PLACED AT RIGHT ANGLES
12271 TOP
(WHITE PINE)
WOOD CLEAT WITH 2 NO. 6 X 1 1/4" (BRASS) WD. SCREW
12272 INTERMEDIATE SHELVES
(WHITE PINE)
12275 EYE BOLT
(WROUGHT IRON)
4 13/16"
9 3/4"
GRAINS PLACED AT RIGHT ANGLES
12278 ASSEMBLY
(WITH FROST BOARD 12276)
122710 ASSEMBLY
(WITH FROST BOARD 12279)
(TO BE DIPPED IN PAINT)
12279 FROST BOARD
(WHITE PINE - FOR DOUBLE CHUTE)
12273 BOTTOM SHELF
(WHITE PINE)
12274 UPRIGHTS
(HARD WOOD)
0 1 2 3 4 5 6 - INCHES
0 1 2 3 4 5 6 - INCHES

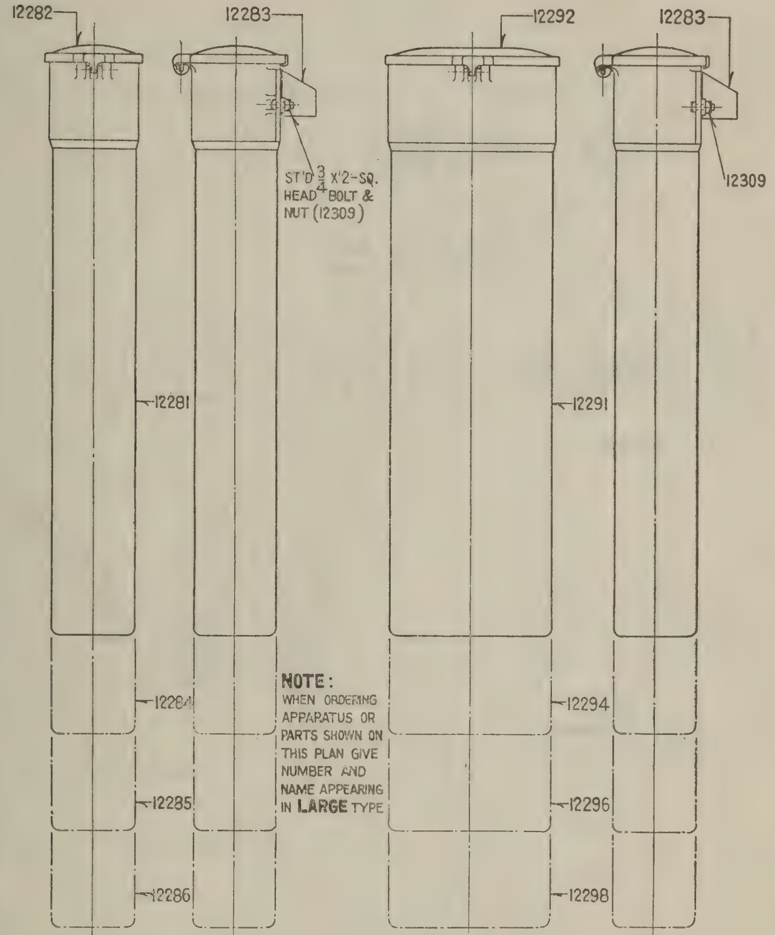
NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NAME AND NUMBER APPEARING IN **LARGE** TYPE.

DETAILS AND ASSEMBLY FOR 3-CELL BATTERY ELEVATOR

RSA 1227

OCT. 1912

Battery Chute. Single and Double. Assembly of.


12282
12283
12292
12283
ST'D $\frac{3}{4}$ X 2'-SQ. HEAD BOLT & NUT (12309)
12309
12281
12291
12284
12294
12285
12296
12286
12298

NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE

ASSEMBLY OF SINGLE CHUTES

12301 = 6 FT. CHUTE
12302 = 6 FT. " [WITH 12278]
12305 = 7 FT. "
12306 = 7 FT. " [WITH 12278]
12309 = 8 FT. "
123010 = 8 FT. " [WITH 12278]
123013 = 9 FT. "
123014 = 9 FT. " [WITH 12278]

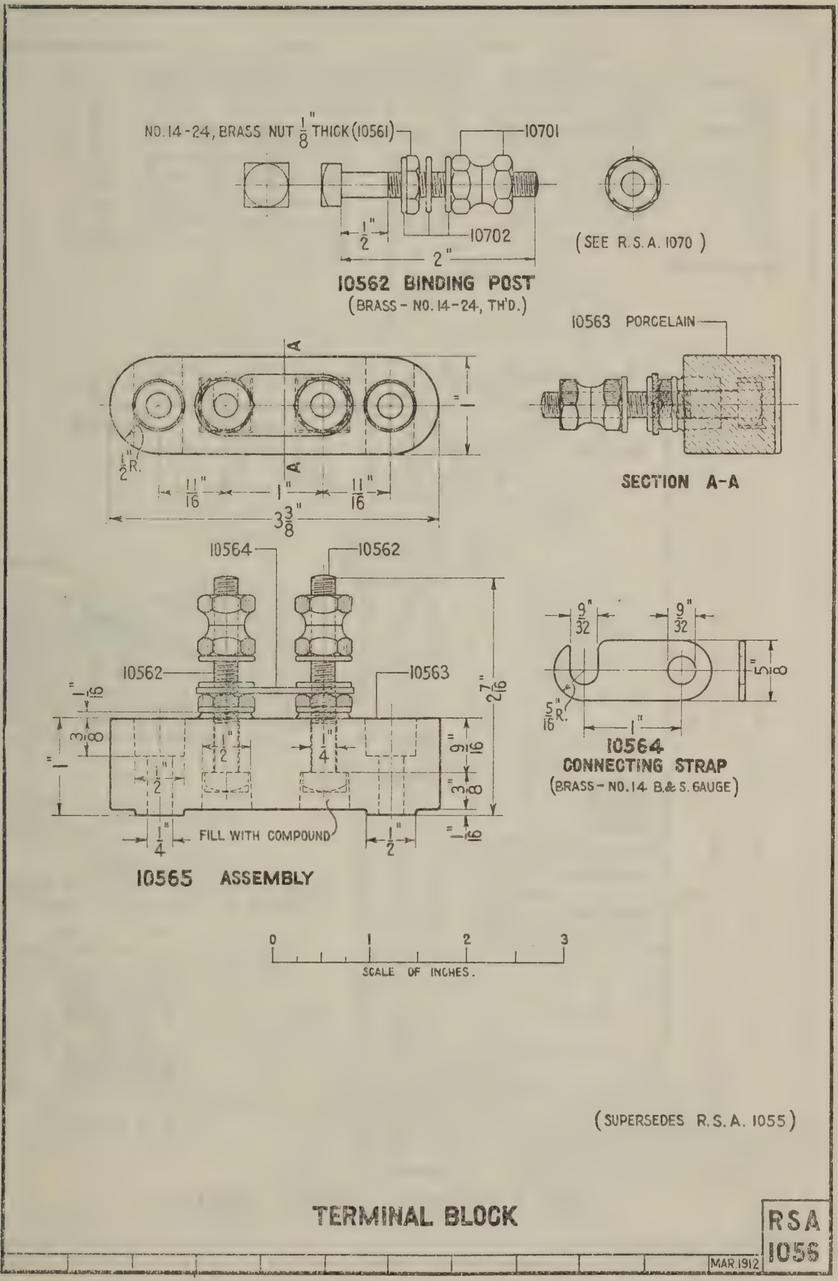
ASSEMBLY OF DOUBLE CHUTES

12303 = 6 FT. CHUTE
12304 = 6 FT. " [WITH 122710 – 12293]
12307 = 7 FT. "
12308 = 7 FT. " [WITH 122710 – 12295]
123011 = 8 FT. "
123012 = 8 FT. " [WITH 122710 – 12297]
123015 = 9 FT. "
123016 = 9 FT. " [WITH 122710 – 12299]

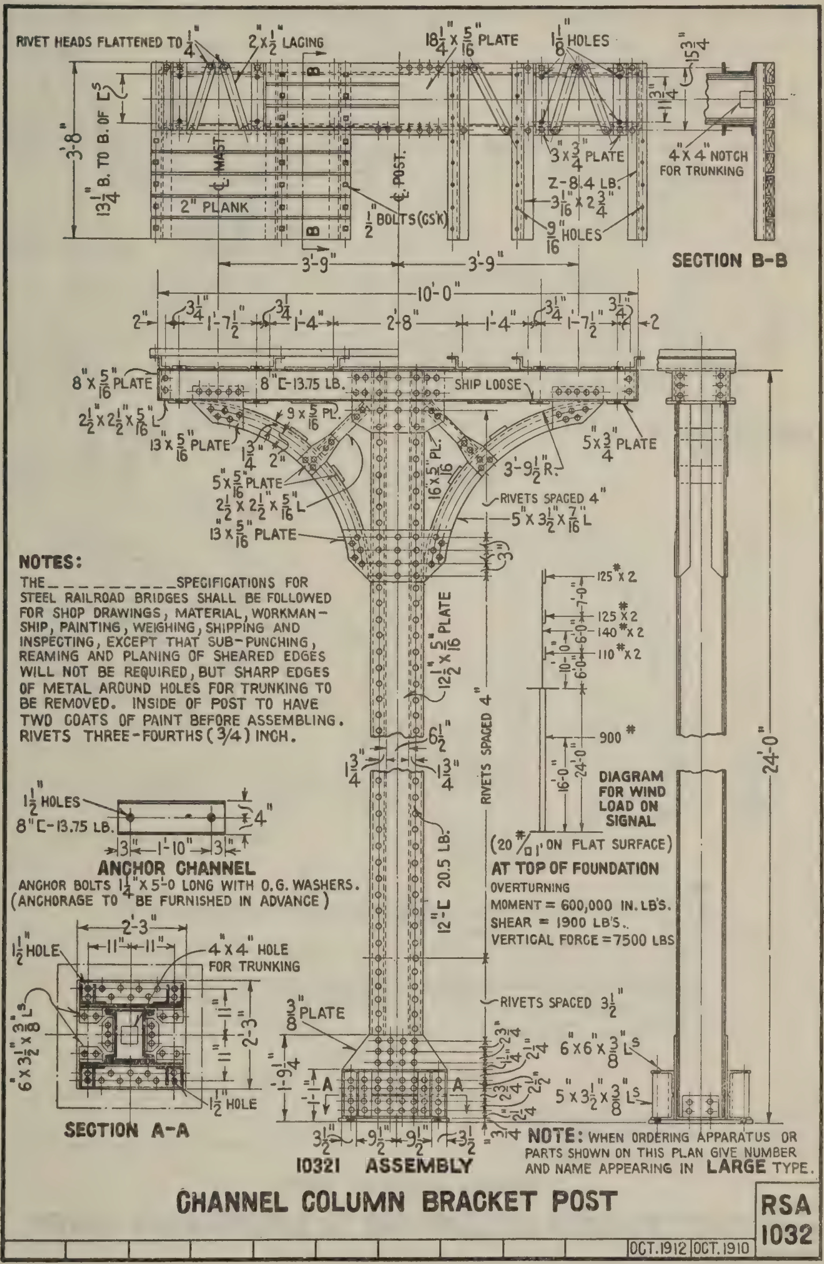
ASSEMBLY OF BATTERY CHUTES

DEC. 1912 | OCT. 1912

RSA 1230


NO. 14-24, BRASS NUT 1/8" THICK (10561)
10701
10702
1/2"
2"
10562 BINDING POST
(BRASS - NO. 14-24, TH'D.)
(SEE R.S.A. 1070)
10563 PORCELAIN
A
A
1"
1/2" R.
11/16"
1"
11/16"
3 3/8"
SECTION A-A
10564
10562
10562
10563
1/16"
3/8"
1"
1/2"
1/2"
1/4"
9/16"
3/8"
2 7/16"
1/16"
1/4"
FILL WITH COMPOUND
1/2"
10565 ASSEMBLY
9/32"
9/32"
5/8"
5/16" R.
1"
10564
CONNECTING STRAP
(BRASS - NO. 14 B.& S. GAUGE)
0
1
2
3
SCALE OF INCHES.
(SUPERSEDES R.S.A. 1055)
TERMINAL BLOCK
RSA
1056
MAR. 1912

Bracket Post.
Channel
Column.


RIVET HEADS FLATTENED TO 1/4"
2"x1/2" LACING
18 1/4" x 5/16" PLATE
1 1/8" HOLES
15 3/4"
13 1/4" B. TO B. OF L^S
3'-8"
3 1/4"
11 3/4"
℄ MAST
℄ POST
2" PLANK
1/2" BOLTS (CS'K)
B
3"x3/4" PLATE
Z-8.4 LB.
3 1/16" x 2 3/4"
9/16" HOLES
4"x4" NOTCH FOR TRUNKING
SECTION B-B
3'-9"
3'-9"
10'-0"
2"
3 1/4"
1'-7 1/2"
3 1/4"
1'-4"
2'-8"
1'-4"
3 1/4"
1'-7 1/2"
3 1/4"
2
8"x5/16" PLATE
8" [-13.75 LB.
SHIP LOOSE
2 1/2"x2 1/2"x5/16" L
9x5/16" PL.
13"x5/16" PLATE
1 3/4"
2"
5"x5/16" PLATE
2 1/2"x2 1/2"x5/16" L
13"x5/16" PLATE
16"x5/16" PL.
5"x3/4" PLATE
3'-9 1/2" R.
RIVETS SPACED 4"
5"x3 1/2"x7/16" L
3"
12 1/2"x5/16" PLATE
RIVETS SPACED 4"
6 1/2"
1 3/4"
1 3/4"
12" [20.5 LB.
125# x 2
125# x 2
140# x 2
110# x 2
900#
7'-0"
6'-0"
6'-0"
10'-0"
24'-0"
16'-0"
DIAGRAM FOR WIND LOAD ON SIGNAL
(20#/□' ON FLAT SURFACE)
24'-0"
1 1/2" HOLES
8" [-13.75 LB.
4"
3"
1'-10"
3"
ANCHOR CHANNEL
2'-3"
1 1/2" HOLE
11"
11"
4"x4" HOLE FOR TRUNKING
6"x3 1/2"x3/8" L^S
11"
11"
2'-3"
1 1/2" HOLE
SECTION A-A
RIVETS SPACED 3 1/2"
3/8" PLATE
2 3/4"
2 1/4"
6"x6"x3/8" L^S
1'-9 1/4"
A
A
2 3/4"
2 1/2"
2 1/4"
5x3 1/2"x3/8" L^S
3/4"
3 1/2"
9 1/2"
9 1/2"
3 1/2"
10321 ASSEMBLY

NOTES:

THE __________ SPECIFICATIONS FOR STEEL RAILROAD BRIDGES SHALL BE FOLLOWED FOR SHOP DRAWINGS, MATERIAL, WORKMANSHIP, PAINTING, WEIGHING, SHIPPING AND INSPECTING, EXCEPT THAT SUB-PUNCHING, REAMING AND PLANING OF SHEARED EDGES WILL NOT BE REQUIRED, BUT SHARP EDGES OF METAL AROUND HOLES FOR TRUNKING TO BE REMOVED. INSIDE OF POST TO HAVE TWO COATS OF PAINT BEFORE ASSEMBLING. RIVETS THREE-FOURTHS (3/4) INCH.

ANCHOR BOLTS 1 1/4" x 5'-0 LONG WITH O. G. WASHERS. (ANCHORAGE TO BE FURNISHED IN ADVANCE)

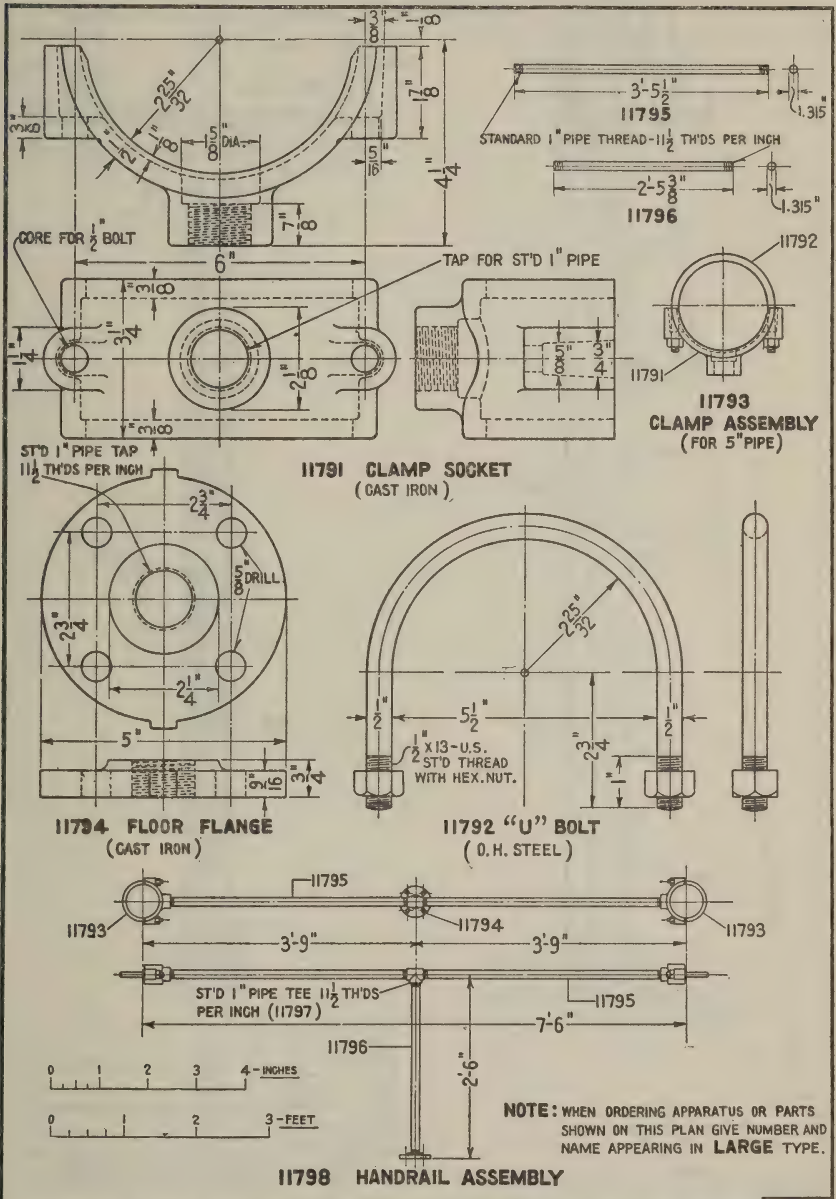
AT TOP OF FOUNDATION
OVERTURNING
MOMENT = 600,000 IN. LB'S.
SHEAR = 1900 LB'S.
VERTICAL FORCE = 7500 LBS

NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE.

CHANNEL COLUMN BRACKET POST

RSA
1032

OCT. 1912 | OCT. 1910



3/8"
1/8"
225/32"
17/8"
3/16"
1 1/8"
1 5/8" DIA.
2"
5/16"
4 1/4"
7/8"
CORE FOR 1/2" BOLT
6"
TAP FOR ST'D 1" PIPE
3/8"
3 1/4"
1 1/4"
2 1/8"
5/8"
3/4"
ST'D 1" PIPE TAP 11 1/2 TH'DS PER INCH
11791 CLAMP SOCKET
(CAST IRON)
3'-5 1/2"
11795
1.315"
STANDARD 1" PIPE THREAD-11 1/2 TH'DS PER INCH
2'-5 3/8"
11796
1.315"
11792
11791
11793
CLAMP ASSEMBLY
(FOR 5" PIPE)
2 3/4"
5/8" DRILL
2 3/4"
2 1/4"
5"
9/16"
3/4"
11794 FLOOR FLANGE
(CAST IRON)
225/32"
5 1/2"
1/2"
1/2"
2 3/4"
1"
1/2" X 13-U.S. ST'D THREAD WITH HEX. NUT.
11792 "U" BOLT
(O.H. STEEL)
11795
11793
11794
11793
3'-9"
3'-9"
ST'D 1" PIPE TEE 11 1/2 TH'DS PER INCH (11797)
11795
7'-6"
11796
2'-6"
0 1 2 3 4-INCHES
0 1 2 3-FEET
11798 HANDRAIL ASSEMBLY

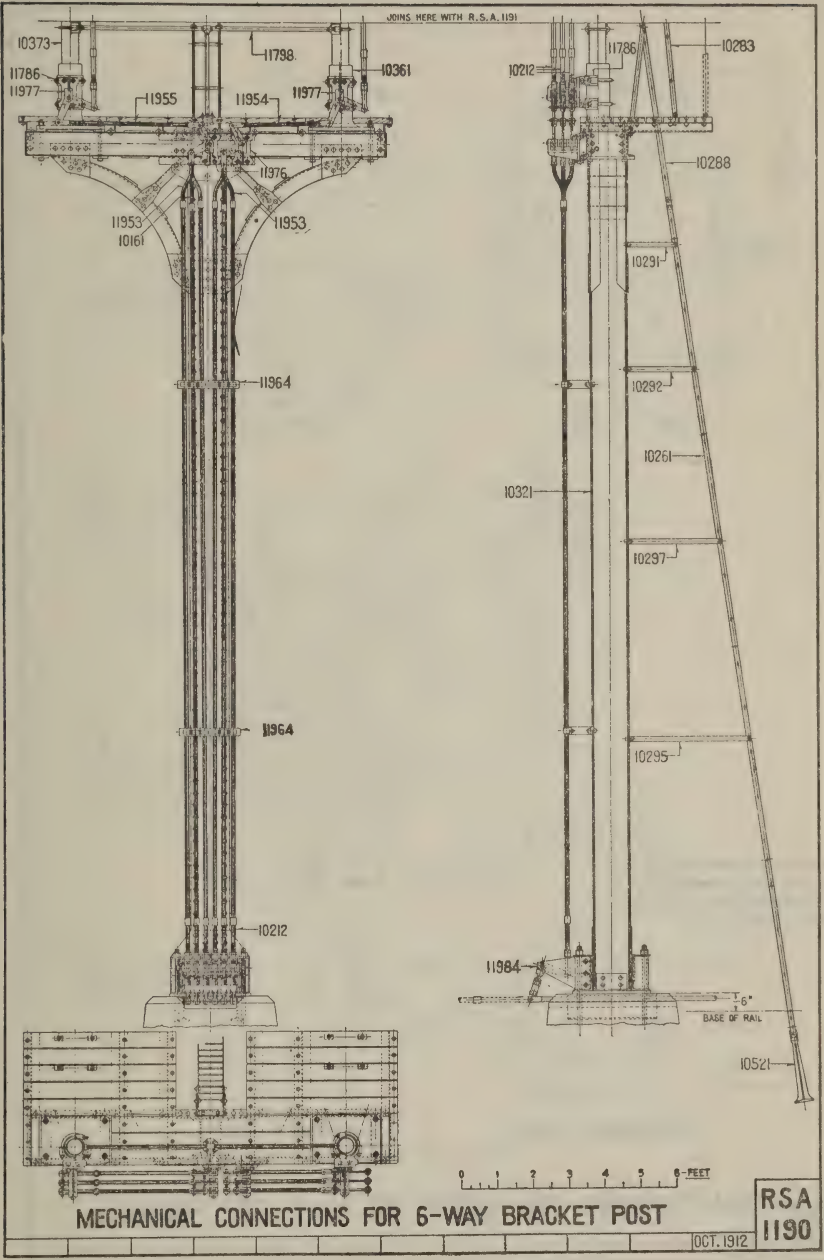
NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE.

DETAILS AND ASSEMBLY OF HANDRAIL FOR BRACKET POST

RSA 1179

OCT. 1912

**Bracket Post.
Six-way.
Mechanical
Connections.**

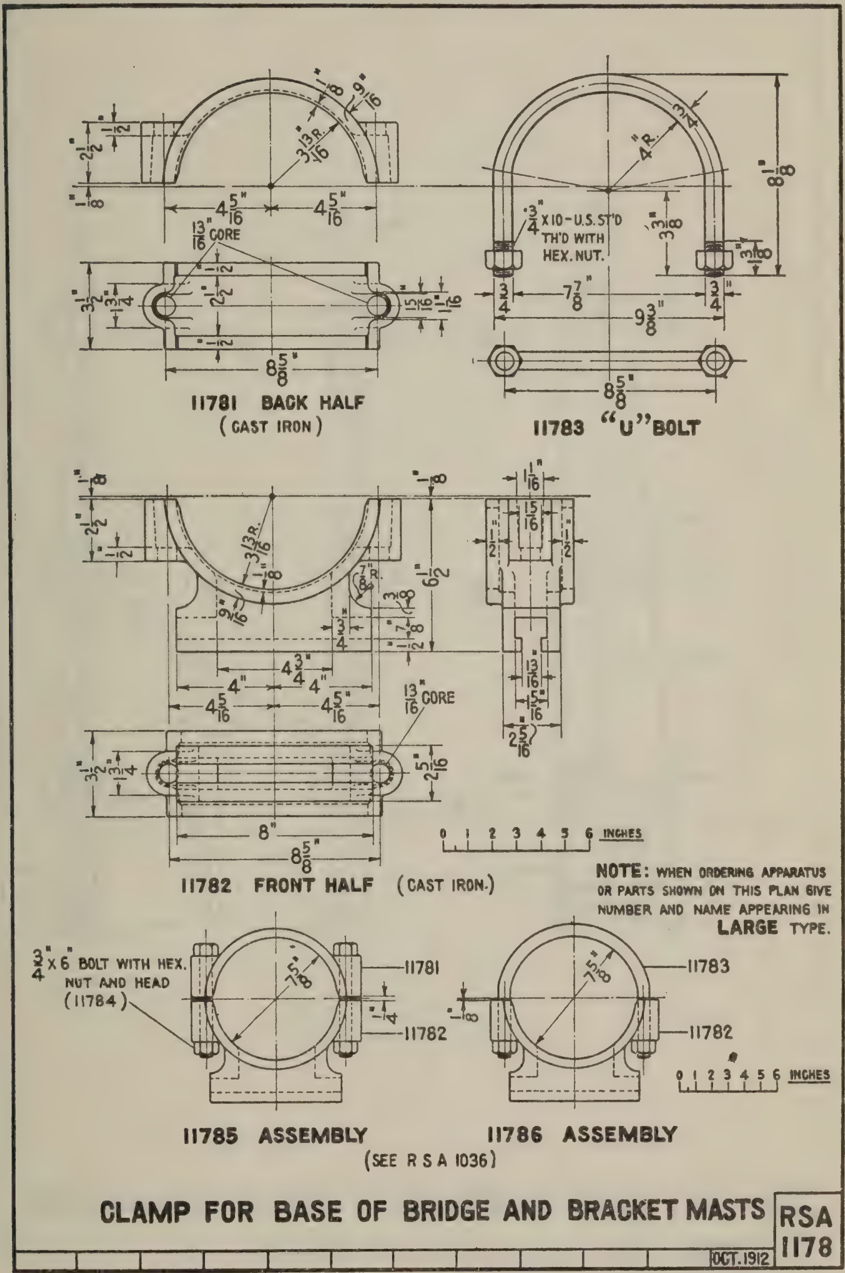


MECHANICAL CONNECTIONS FOR 6-WAY BRACKET POST

OCT. 1912

RSA 1190

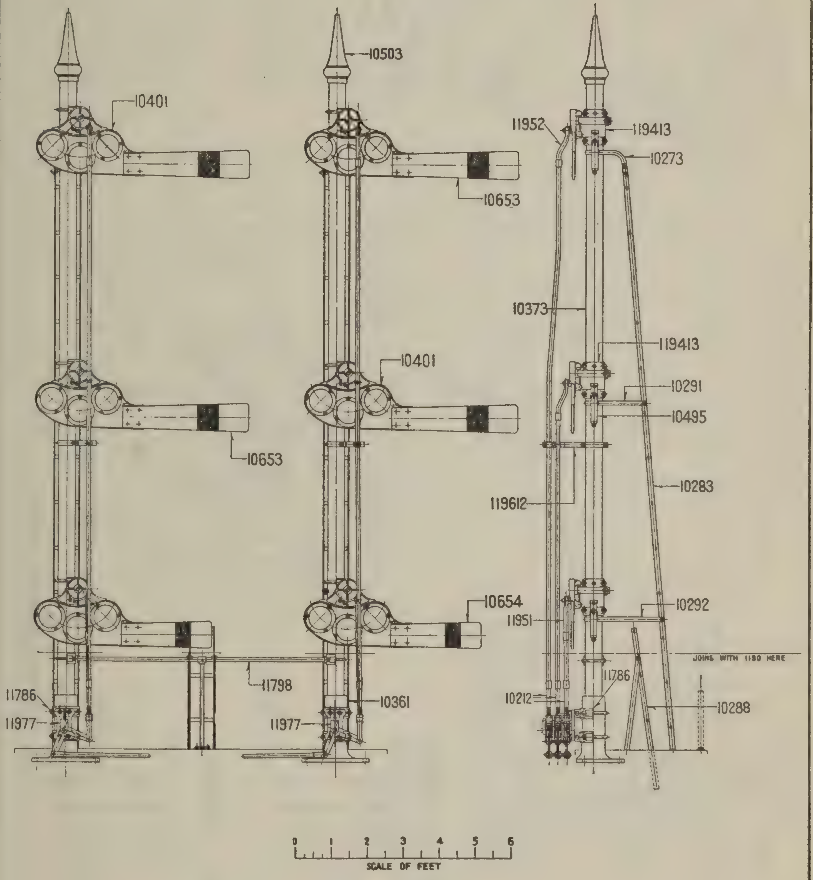
JOINS HERE WITH R.S.A. 1191
10373
11786
11977
11798
10361
11977
11955
11954
11976
11953
10161
11953
11964
11964
10212
10212
11786
10283
10288
10291
10292
10261
10321
10297
10295
11984
6"
BASE OF RAIL
10521
0 1 2 3 4 5 6 FEET


11781 BACK HALF
(CAST IRON)
11783 "U" BOLT
11782 FRONT HALF (CAST IRON.)
11785 ASSEMBLY
11786 ASSEMBLY
(SEE R S A 1036)
13/16" CORE
3/4" X 10 - U.S. ST'D TH'D WITH HEX. NUT.
3/4" X 6" BOLT WITH HEX. NUT AND HEAD (11784)
11781
11782
11783
4" R.
3 13/16 R.
7/8" R.
7 5/8"
4 5/16"
8 5/8"
9 3/8"
7 7/8"
8 1/8"
6 1/2"
4 3/4"
4"
8"
0 1 2 3 4 5 6 INCHES
RSA 1178
OCT. 1912

NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE.

CLAMP FOR BASE OF BRIDGE AND BRACKET MASTS

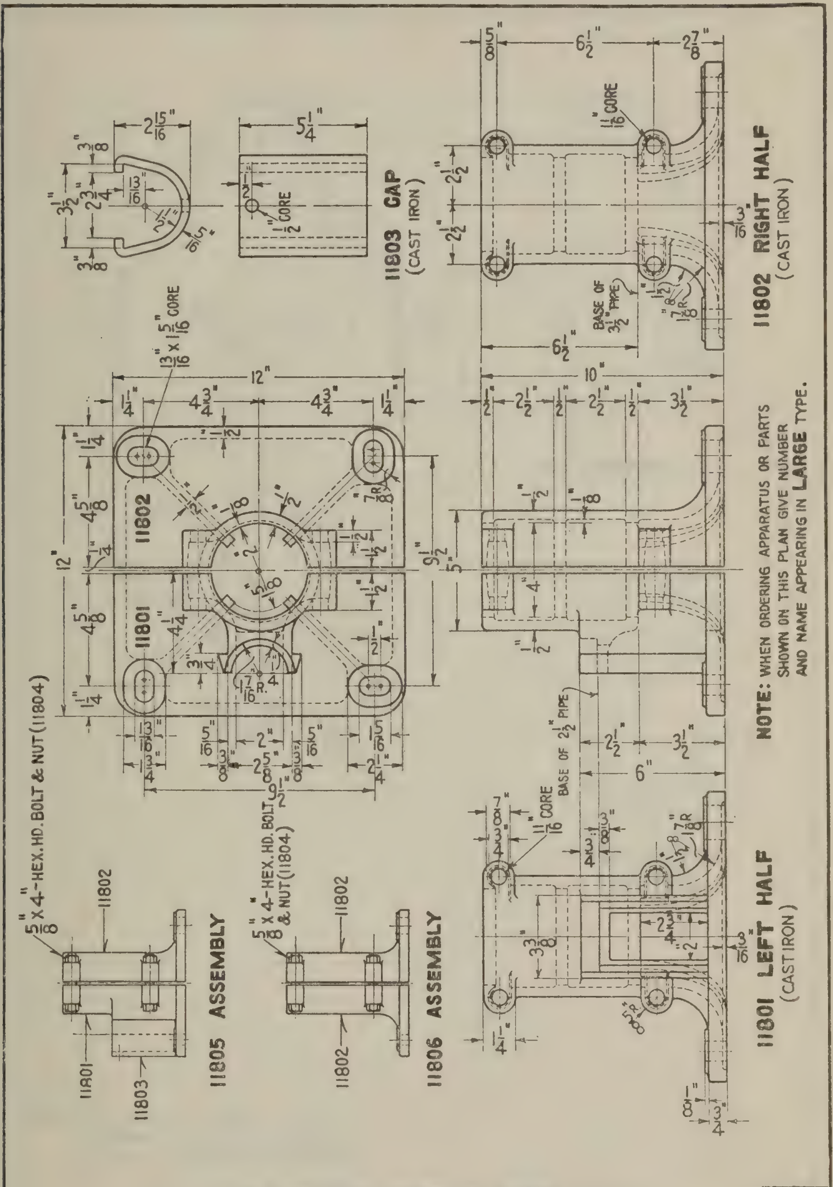
Bridge and Bracket Masts. Three-arm. Mech. Con.


10503
10401
10653
10401
10653
10654
11798
10361
11786
11977
11977
11952
119413
10273
10373
119413
10291
10495
10283
119612
10292
11951
JOINS WITH 1190 HERE
11786
10212
10288
0 1 2 3 4 5 6
SCALE OF FEET

MECHANICAL CONNECTIONS FOR 3-ARM BRIDGE AND BRACKET MASTS

RSA 1191

OCT. 1912


11803 CAP
(CAST IRON)
1/2" CORE
11802 RIGHT HALF
(CAST IRON)
11/16" CORE
BASE OF 3 1/2" PIPE
11801 LEFT HALF
(CAST IRON)
BASE OF 2 1/2" PIPE
11802
11801
13/16" X 1 5/16" CORE
5/8" X 4"-HEX.HD.BOLT & NUT (11804)
5/8" X 4"-HEX.HD.BOLT & NUT (11804)
11805 ASSEMBLY
11806 ASSEMBLY
11801
11802
11803
12"
10"
6"
6 1/2"
9 1/2"

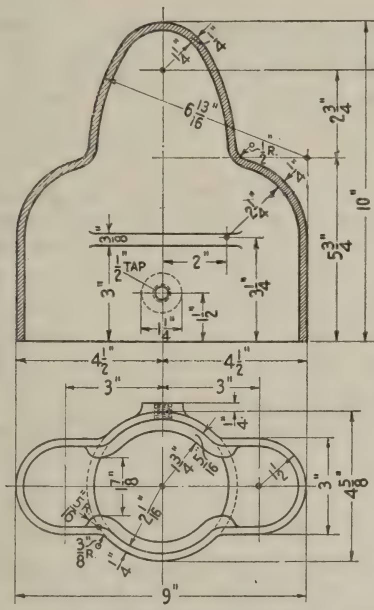
NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE.

BASE FOR CABLE POST

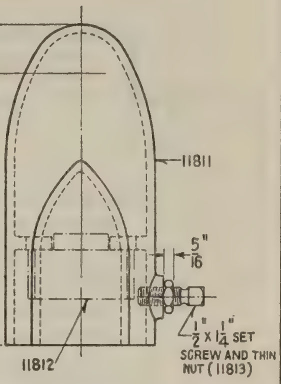
RSA
1180

OCT. 1912 JUN. 1912

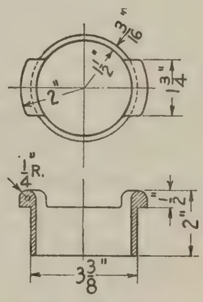
Cap and Bushing. Cable Post


1/4"
1/4"
6 13/16"
1/2" R.
2 3/4"
1/4"
2 1/4"
10"
5 3/4"
3/8"
1/2" TAP
2"
3"
3 1/4"
1/2"
1 1/4"
4 1/2"
4 1/2"
3"
3"
1/4"
1 3/4"
5/16"
1 7/8"
1/2"
3"
4 5/8"
5/16" R.
2 1/16"
3/8" R.
1/4"
9"

11811 CAP
(CAST IRON)


11811
5/16"
1/2" x 1 1/4" SET SCREW AND THIN NUT (11813)
11812

11814 ASSEMBLY (WITH BUSHING)


3/16"
1 1/2"
2"
1 3/4"
1/4" R.
1/2"
2"
3 3/8"

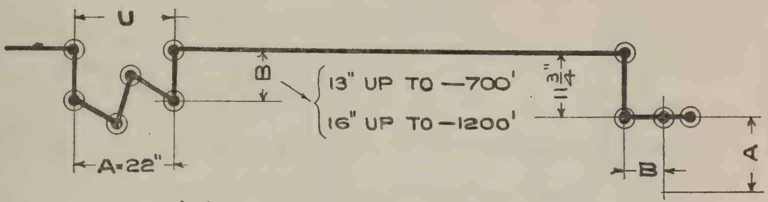
11812 BUSHING
(CAST IRON)

NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE.

CAP AND BUSHING FOR CABLE POST

OCT. 1912 JUN. 1912

RSA 1181



VALUES OF "U" ARE BASED ON .08 OF AN INCH AS COEFFICIENT OF EXPANSION FOR AN INCREASE OF 10° F. FOR EACH 100' OF LINE, AND THE NEAREST $\frac{1}{16}$" IS GIVEN. VALUES OF SPACING "U" FOR GIVEN TEMPERATURE, AND LENGTH OF LINES COMPENSATED AND TABLE OF EQUIVALENT LENGTHS TO BE USED IN COMPENSATING PIPE LINES WHEN CRANK ARMS ARE OF UNEQUAL LENGTHS.

TEMP	LENGTHS OF LINES COMPENSATED IN FEET.											
FAH	100'	200'	300'	400'	500'	600'	700'	800'	900'	1000'	1100'	1200'
110°	$21\frac{1}{2}$"	21"	$20\frac{1}{2}$"	20"	$19\frac{1}{2}$"	19"	$18\frac{1}{2}$"	18"	$17\frac{1}{2}$"	17"	$16\frac{1}{2}$"	16"
90°	$21\frac{11}{16}$"	$21\frac{3}{8}$"	21"	$20\frac{11}{16}$"	$20\frac{3}{8}$"	20"	$19\frac{11}{16}$"	$19\frac{3}{8}$"	19"	$18\frac{11}{16}$"	$18\frac{1}{2}$"	$18\frac{1}{4}$"
70°	$21\frac{13}{16}$"	$21\frac{11}{16}$"	$21\frac{9}{16}$"	$21\frac{3}{8}$"	$21\frac{3}{16}$"	21"	$20\frac{7}{8}$"	$20\frac{11}{16}$"	$20\frac{1}{2}$"	$20\frac{3}{8}$"	$20\frac{1}{4}$"	$20\frac{1}{8}$"
50°	MEAN TEMPERATURE U = A = 22"											
30°	$22\frac{3}{16}$"	$22\frac{5}{16}$"	$22\frac{1}{2}$"	$22\frac{5}{8}$"	$22\frac{13}{16}$"	23"	$23\frac{3}{16}$"	$23\frac{5}{16}$"	$23\frac{1}{2}$"	$23\frac{5}{8}$"	$23\frac{3}{4}$"	$23\frac{15}{16}$"
10°	$22\frac{5}{16}$"	$22\frac{5}{8}$"	23"	$23\frac{5}{16}$"	$23\frac{5}{8}$"	$23\frac{15}{16}$"	$24\frac{1}{4}$"	$24\frac{9}{16}$"	$24\frac{7}{8}$"	$25\frac{3}{16}$"	$25\frac{1}{2}$"	$25\frac{7}{8}$"
0°	$22\frac{7}{16}$"	$22\frac{13}{16}$"	$23\frac{1}{4}$"	$23\frac{5}{8}$"	$24\frac{1}{16}$"	$24\frac{7}{16}$"	$24\frac{13}{16}$"	$25\frac{1}{4}$"	$25\frac{11}{16}$"	$26\frac{1}{8}$"	$26\frac{1}{2}$"	$26\frac{13}{16}$"
-10°	$22\frac{1}{2}$"	23"	$23\frac{1}{2}$"	24"	$24\frac{1}{2}$"	25"	$25\frac{1}{2}$"	26"	$26\frac{1}{2}$"	27"	$27\frac{1}{2}$"	28"

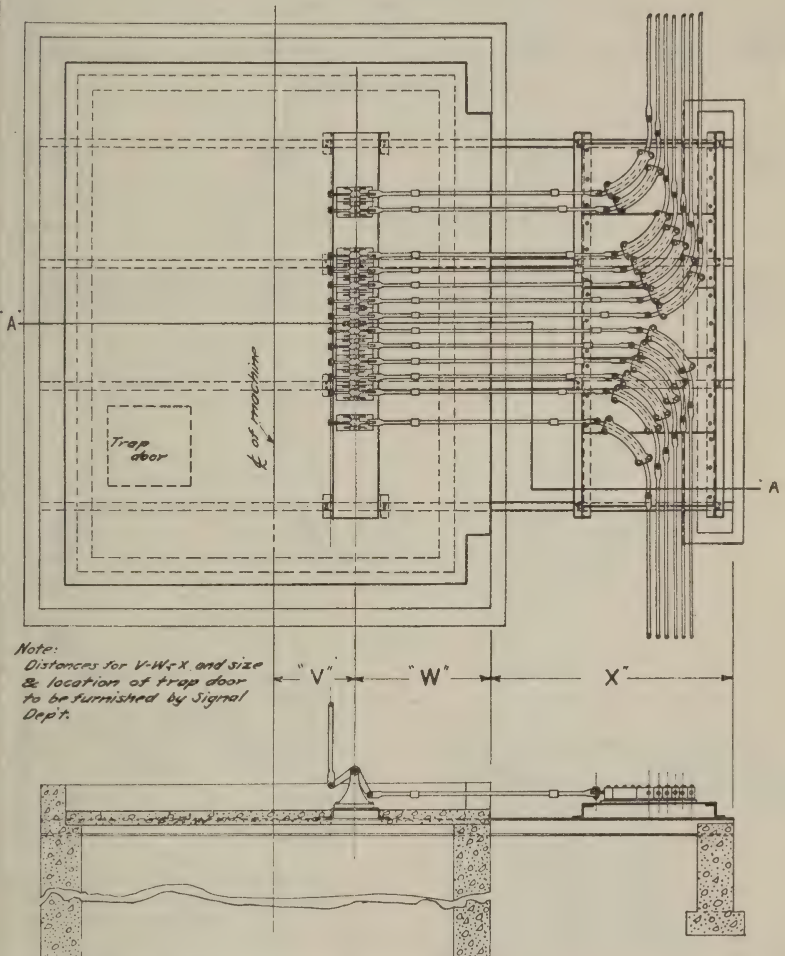
"A" LENGTH IN. FT.	EQUIVALENT FOR "A" FOR VARIOUS LENGTHS OF "B"											
	B=7"	B=$7\frac{1}{2}$"	B=8"	B=$8\frac{1}{2}$"	B=9"	B=$9\frac{1}{2}$"	B=10"					
25	42	39	37	35	33	31	29					
50	84	78	73	69	65	62	59					
75	126	117	110	104	98	93	88					
100	168	157	147	138	130	124	117					
150	252	235	220	207	196	185	176					
200	336	313	294	276	261	247	235					
250	419	391	367	345	326	309	294					
300	503	470	441	415	391	371	352					
350	587	548	514	484	457	433	411					

NOTE:- SINCE THE MEAN TEMP. VARIES, IT MUST BE TAKEN FOR THE LATITUDE WHERE THE WORK IS DONE.

COMPENSATION TABLE-PIPE.

MANUAL- MAR. 1913 | OCT. 1909

RSA 1102


A
A
Trap door
℄ of machine
"V"
"W"
"X"

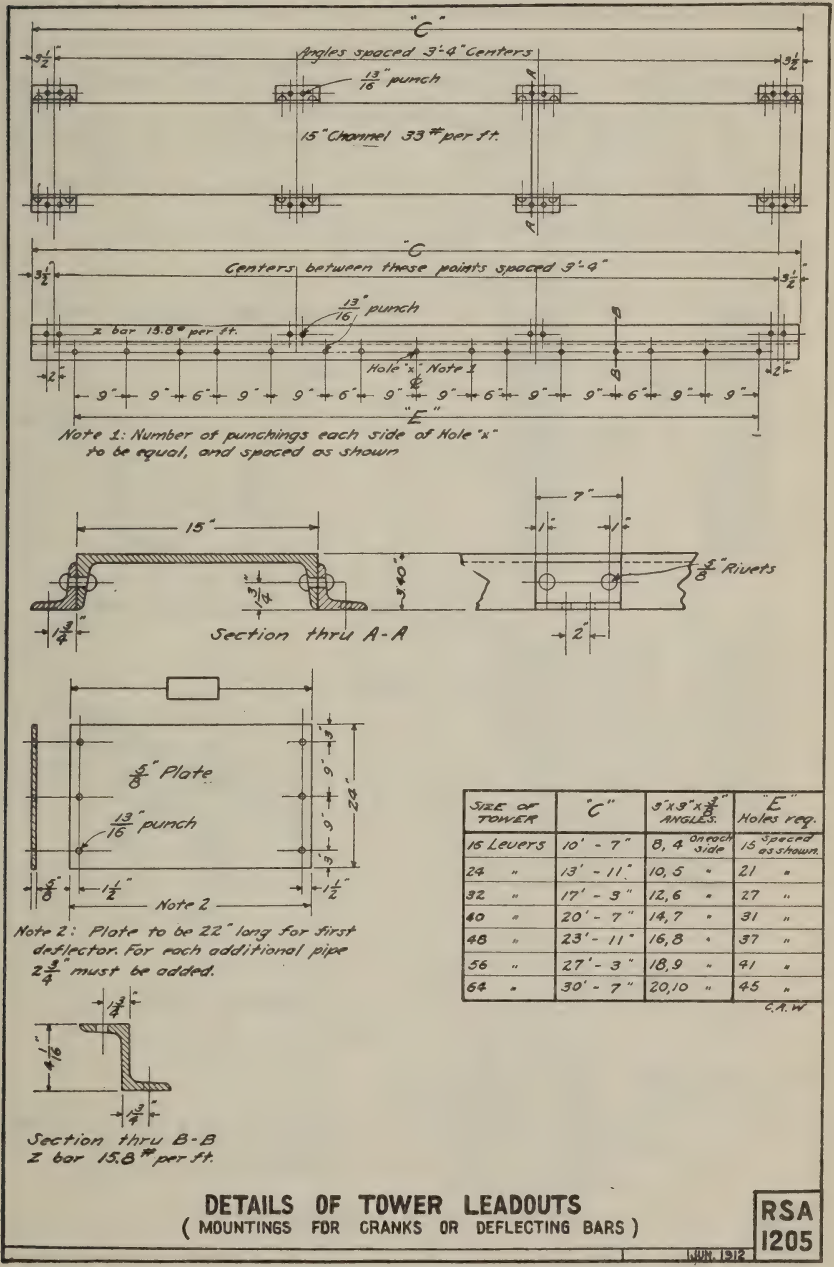
Note:
Distances for V-W-X and size & location of trap door to be furnished by Signal Dep't.

Section thru A-A

TOWER LEADOUTS
(MOUNTED CRANKS AND DEFLECTING BARS)

JUN. 1912

RSA
1204


"C"
$3\frac{1}{2}$"
Angles spaced 3'-4" Centers
$\frac{13}{16}$" punch
15" Channel 33# per ft.
A
A
"C"
Centers between these points spaced 3'-4"
z bar 13.8# per ft.
Hole "x" Note 1
B
B
2"
9" 9" 6" 9" 9" 6" 9" 9" 6" 9" 9" 6" 9" 9"
℄
"E"
15"
$3\frac{3}{4}$"
3.40"
$1\frac{3}{4}$"
Section thru A-A
7"
1"
1"
$\frac{5}{8}$" Rivets
2"
$\frac{5}{8}$" Plate
$\frac{13}{16}$" punch
3"
9"
9"
3"
24"
$\frac{5}{8}$"
$1\frac{1}{2}$"
$1\frac{1}{2}$"
Note 2
$1\frac{3}{4}$"
$4\frac{1}{16}$"
$1\frac{3}{4}$"
Section thru B-B
Z bar 15.8# per ft.

Note 1: Number of punchings each side of Hole "x" to be equal, and spaced as shown

Note 2: Plate to be 22" long for first deflector. For each additional pipe $2\frac{3}{4}$" must be added.

SIZE OF TOWER	"C"	$3" \times 3" \times \frac{3}{8}"$ ANGLES.	"E" Holes req.
16 Levers	10' - 7"	8, 4 On each side	15 Spaced as shown.
24 "	13' - 11"	10, 5 "	21 "
32 "	17' - 3"	12, 6 "	27 "
40 "	20' - 7"	14, 7 "	31 "
48 "	23' - 11"	16, 8 "	37 "
56 "	27' - 3"	18, 9 "	41 "
64 "	30' - 7"	20, 10 "	45 "

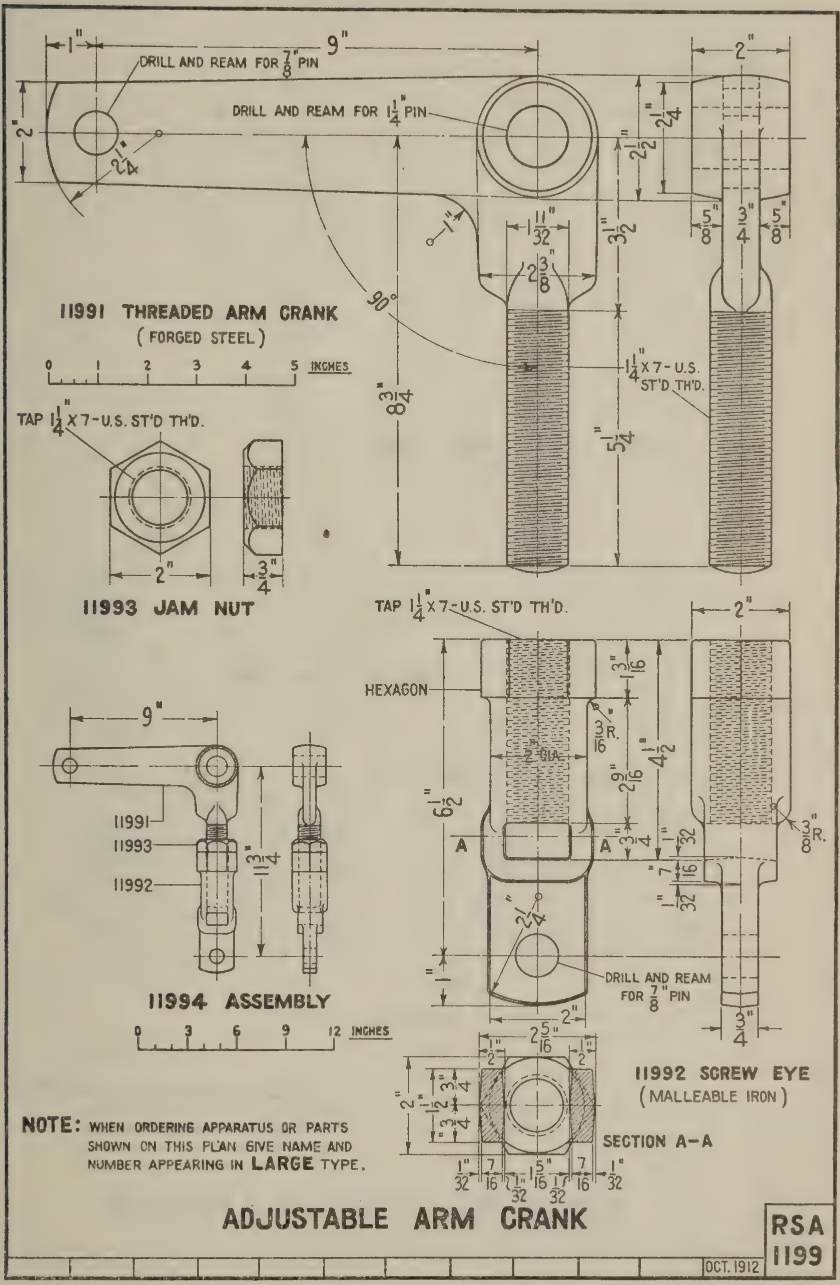
C.A.W

DETAILS OF TOWER LEADOUTS
(MOUNTINGS FOR CRANKS OR DEFLECTING BARS)

JUN. 1912

RSA
1205

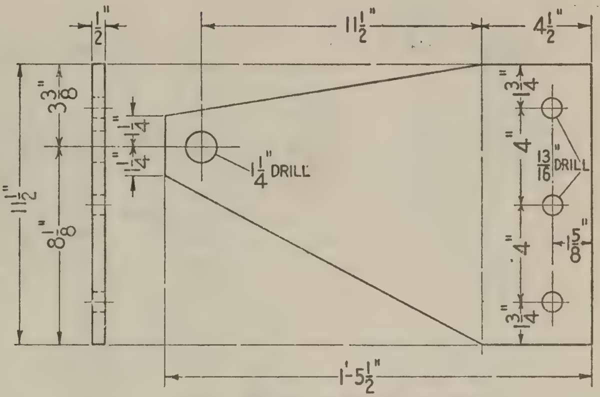
Cranks. Adjustable Arm.



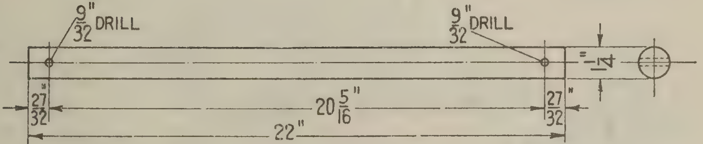
9"
1"
2"
DRILL AND REAM FOR 7/8" PIN
DRILL AND REAM FOR 1 1/4" PIN
2 1/4"
2 1/2"
2 1/4"
1"
1 11/32"
2 3/8"
3 1/2"
5/8"
3/4"
5/8"
90°
8 3/4"
5 1/4"
1 1/4" X 7-U.S. ST'D TH'D.
11991 THREADED ARM CRANK
(FORGED STEEL)
0 1 2 3 4 5 INCHES
TAP 1 1/4" X 7-U.S. ST'D TH'D.
2"
3/4"
11993 JAM NUT
TAP 1 1/4" X 7-U.S. ST'D TH'D.
HEXAGON
1 3/16"
3/16 R.
2" DIA.
2 9/16"
4 1/2"
6 1/2"
3/4"
1/32"
7/16
1/32"
3/8 R.
A
A
2 1/4"
1"
DRILL AND REAM FOR 7/8" PIN
2"
3/4"
9"
11991
11993
11992
11 3/4"
11994 ASSEMBLY
0 3 6 9 12 INCHES
2 5/16"
1/2"
1/2"
2"
3/4"
1/2"
3/4"
1/32"
7/16
1 1/32"
1 5/16"
17/32
7/16
1/32"
SECTION A-A
11992 SCREW EYE
(MALLEABLE IRON)
OCT. 1912
RSA
1199

NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NAME AND NUMBER APPEARING IN **LARGE** TYPE.

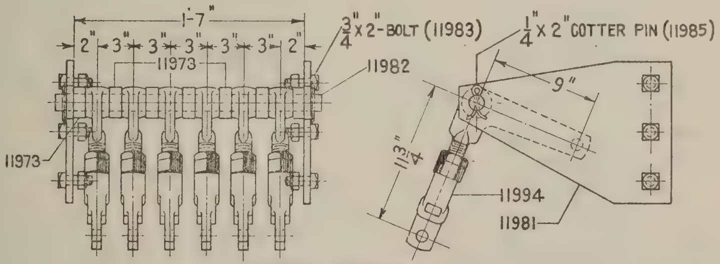
ADJUSTABLE ARM CRANK


1/2"
11 1/2"
4 1/2"
3 3/8"
1 1/4"
1 1/4"
11 1/2"
8 1/8"
1 1/4" DRILL
1 3/4"
4"
13/16" DRILL
4"
1 5/8"
1 3/4"
1'-5 1/2"

11981 CRANK BEARING BRACKET
(STEEL PLATE)


9/32" DRILL
9/32" DRILL
1 1/4"
27/32"
20 5/16"
27/32"
22"
0
1
2
3
4
5
6
INCHES

11982 CRANK BEARING
(C. R. STEEL)


1'-7"
2"
3"
3"
3"
3"
3"
2"
11973
3/4" x 2" BOLT (11983)
11982
11973
1/4" x 2" COTTER PIN (11985)
9"
11 3/4"
11994
11981

11984 ASSEMBLY

0
3
6
9
12
INCHES

NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NAME AND NUMBER APPEARING IN **LARGE** TYPE.

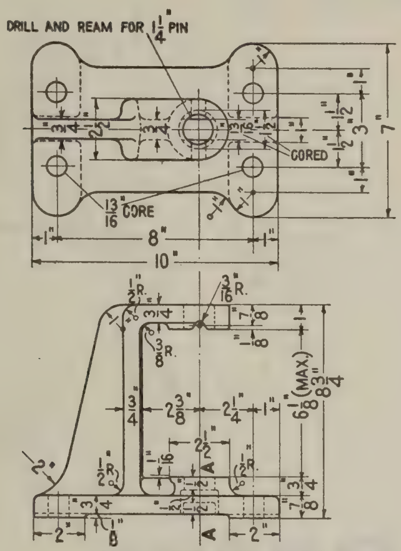
ADJUSTABLE ARM CRANKS AND SUPPORT

(DETAILS AND ASSEMBLY FOR 6-WAYS ON BRACKET POST)

OCT. 1912

RSA
1198

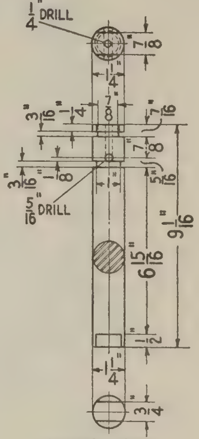
Crank
Stands.
Assembly.



DRILL AND REAM FOR $1\frac{1}{4}$" PIN
$\frac{13}{16}$" CORE
CORED
8"
10"
1"
7"
3"
$1\frac{1}{2}$"
$2\frac{1}{2}$"
$\frac{3}{4}$"
$\frac{1}{2}$" R.
$\frac{3}{16}$" R.
$\frac{3}{8}$" R.
$2\frac{3}{8}$"
$2\frac{1}{4}$"
$6\frac{1}{8}$" (MAX.)
$8\frac{3}{4}$"
$\frac{7}{8}$"
$2\frac{1}{2}$"
$\frac{1}{16}$"
2"
A

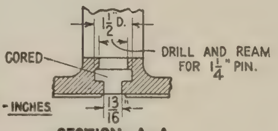
10571 THREE-WAY CRANK STAND
(CAST IRON)

0 3 6 9-INCHES



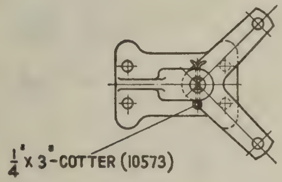
$\frac{1}{4}$" DRILL
$\frac{7}{8}$
$1\frac{1}{4}$"
$\frac{3}{16}$"
$\frac{7}{16}$
$\frac{5}{16}$" DRILL
$\frac{5}{16}$"
$9\frac{1}{16}$"
$6\frac{15}{16}$"
$\frac{1}{2}$
$\frac{3}{4}$

10572 PIN
(C. R. STEEL)

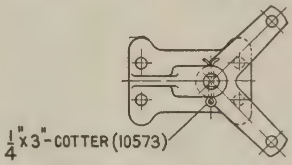


$1\frac{1}{2}$ D.
CORED
DRILL AND REAM FOR $1\frac{1}{4}$" PIN.
$\frac{13}{16}$"

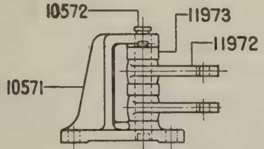
SECTION A-A



$\frac{1}{4}$" x 3"-COTTER (10573)



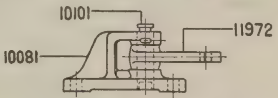
$\frac{1}{4}$" x 3"-COTTER (10573)



10572
11973
11972
10571

10574 ASSEMBLY (7" x 7" CRANKS)
10575 ASSEMBLY (9" x 9" CRANKS)

0 3 6 9 12-INCHES



10101
11972
10081

ONE-WAY CRANK STAND
10576 ASSEMBLY (7" x 7" CRANK)
10577 ASSEMBLY (9" x 9" CRANK)

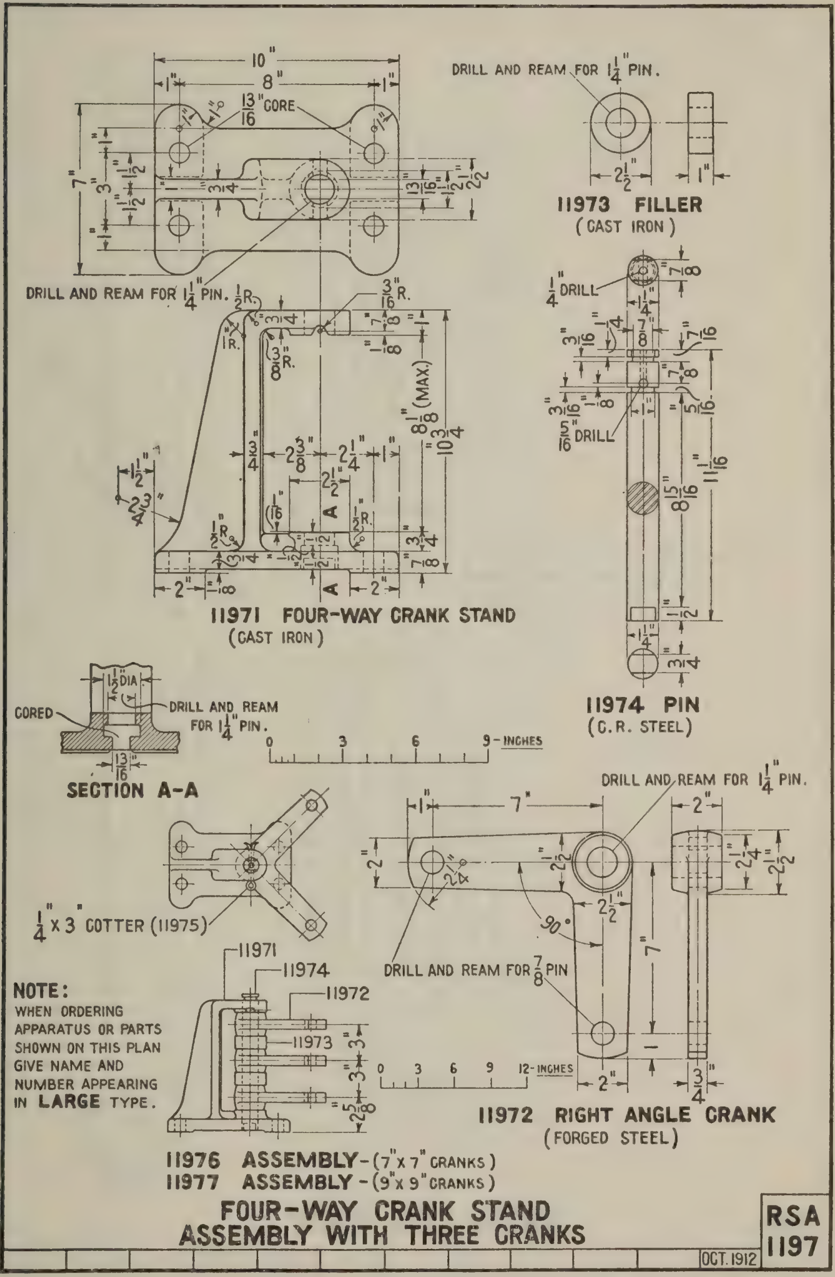
NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NAME AND NUMBER APPEARING IN **LARGE** TYPE.

CRANK STANDS
ASSEMBLY WITH ONE AND TWO CRANKS

OCT. 1912

RSA
1057

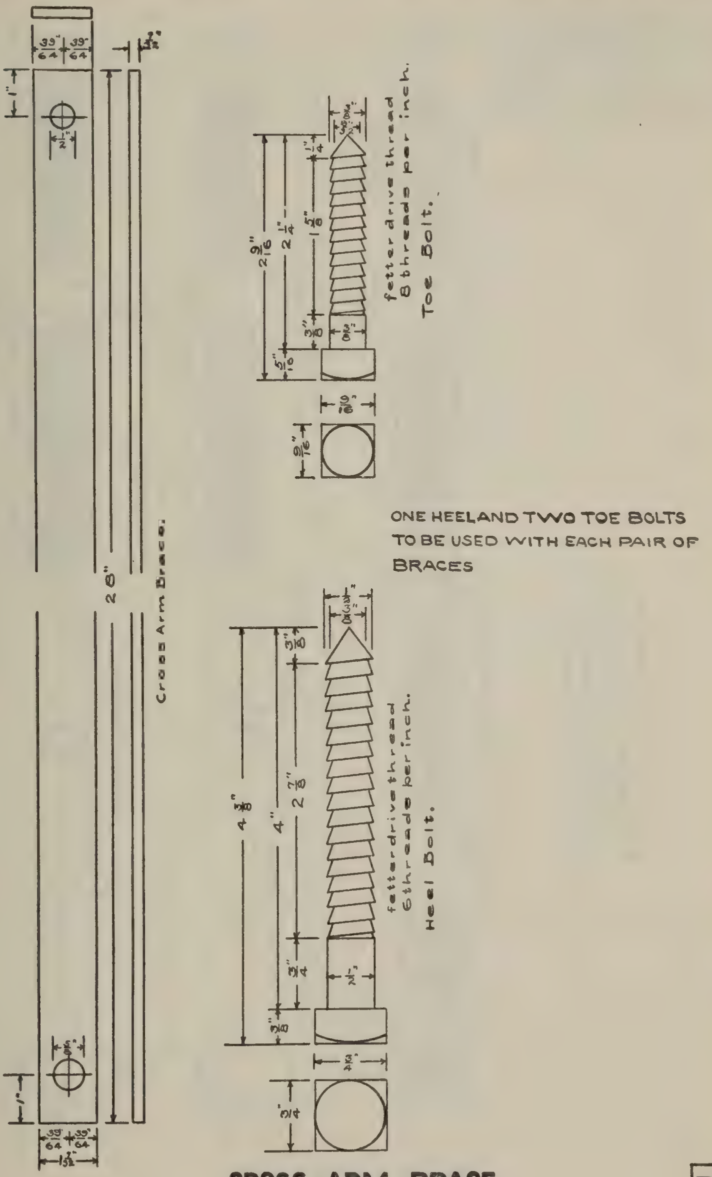
Crank Stands. Four-way With Three Cranks.


DRILL AND REAM FOR 1¼" PIN.
13/16" CORE
11971 FOUR-WAY CRANK STAND
(CAST IRON)
11973 FILLER
(CAST IRON)
¼" DRILL
5/16" DRILL
11974 PIN
(C.R. STEEL)
CORED
DRILL AND REAM FOR 1¼" PIN.
1½" DIA
SECTION A-A
0 3 6 9 - INCHES
¼" x 3" COTTER (11975)
DRILL AND REAM FOR 7/8 PIN
11971
11974
11972
11973
0 3 6 9 12 - INCHES
11972 RIGHT ANGLE CRANK
(FORGED STEEL)
11976 ASSEMBLY - (7" x 7" CRANKS)
11977 ASSEMBLY - (9" x 9" CRANKS)
OCT. 1912

NOTE:
WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NAME AND NUMBER APPEARING IN **LARGE** TYPE.

FOUR-WAY CRANK STAND ASSEMBLY WITH THREE CRANKS

RSA 1197


39"/64
1"
1/2"
28"
Cross Arm Brace.
fetter drive thread 8 threads per inch.
Toe Bolt.
2 9/16"
2 1/4"
1 5/8"
1/4"
3/8"
5/16"
9/16"
fetter drive thread 6 threads per inch.
Heel Bolt.
4 3/8"
4"
2 7/8"
3/4"
3/8"
1 5/32"

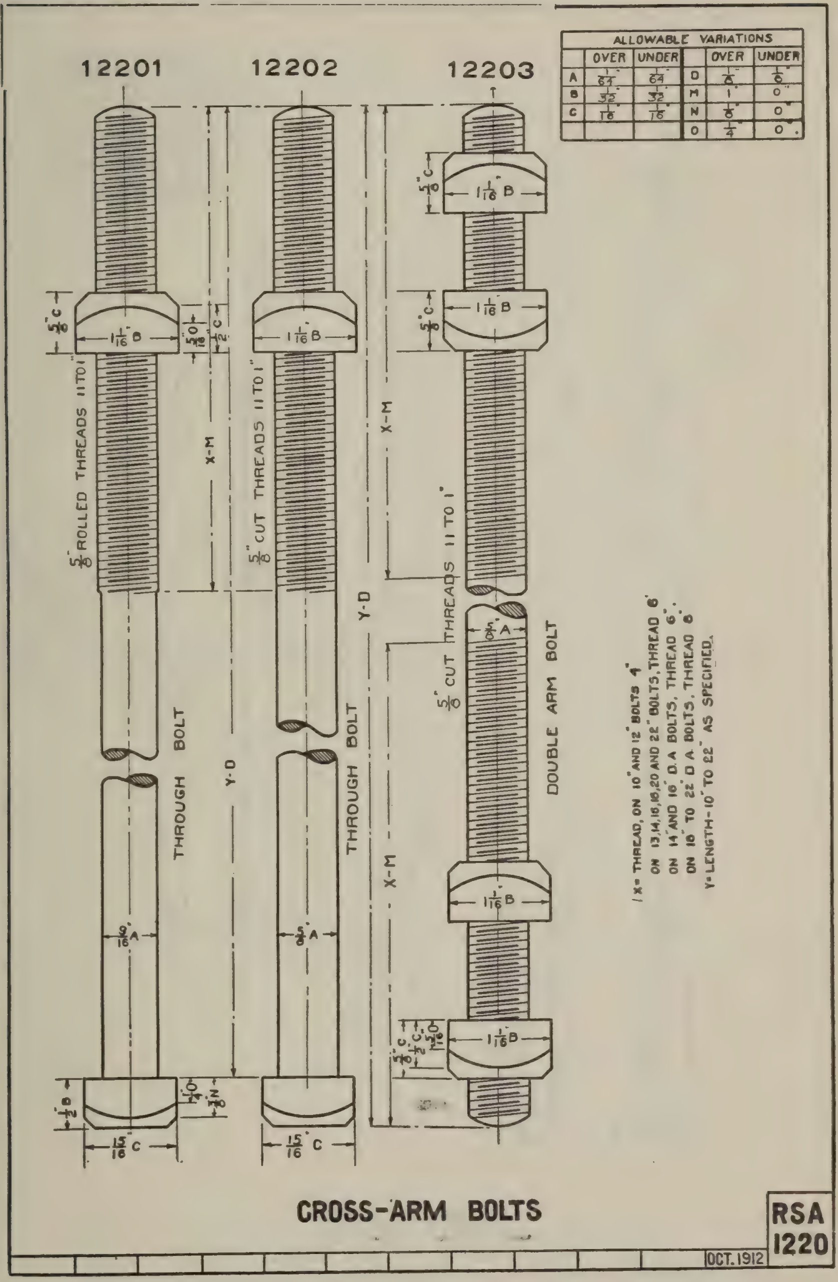
ONE HEEL AND TWO TOE BOLTS TO BE USED WITH EACH PAIR OF BRACES

CROSS-ARM BRACE

OCT. 1912

RSA 1219

Crossarm Bolts.


12201
12202
12203
5/8" ROLLED THREADS 11 TO 1"
5/8" CUT THREADS 11 TO 1"
5/8" CUT THREADS 11 TO 1"
THROUGH BOLT
THROUGH BOLT
DOUBLE ARM BOLT
X-M
Y-D
5/8" C
5/16" O
1/2" C
1 1/16" B
9/16" A
5/8" A
1/2" B
1/4" O
3/8" N
15/16" C

ALLOWABLE VARIATIONS					
	OVER	UNDER		OVER	UNDER
A	1/64"	1/64"	D	1/8"	1/8"
B	1/32"	1/32"	M	1"	0"
C	1/16"	1/16"	N	1/8"	0"
			O	1/4"	0".

1 X= THREAD, ON 10" AND 12" BOLTS 4"
ON 13,14,16,18,20 AND 22" BOLTS, THREAD 6"
ON 14" AND 16" D. A BOLTS, THREAD 6".
ON 18" TO 22" D. A. BOLTS, THREAD 8"
Y= LENGTH-10" TO 22" AS SPECIFIED.

CROSS-ARM BOLTS

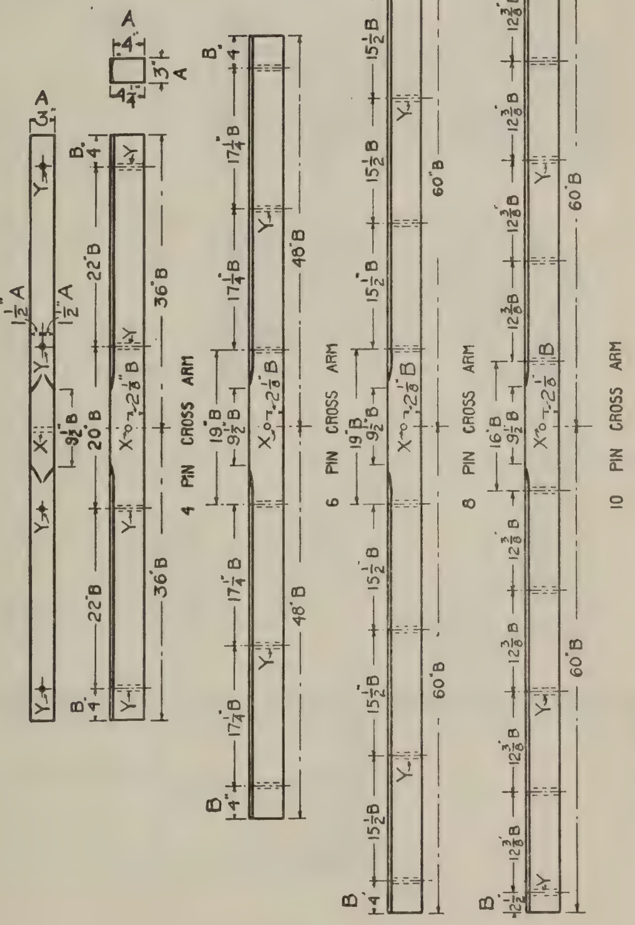
OCT. 1912

RSA 1220

Crossarms.
Wood, for
Signal Work.

ALLOWABLE VARIATIONS		
	OVER	UNDER
A	$\frac{1}{16}''$	$\frac{1}{16}''$
B	$\frac{1}{8}''$	$\frac{1}{8}''$

SIZE OF HOLES
X = BOLT HOLES $\frac{11}{16}''$ DIA.
Y = PIN HOLES $\frac{9}{16}''$ DIA.

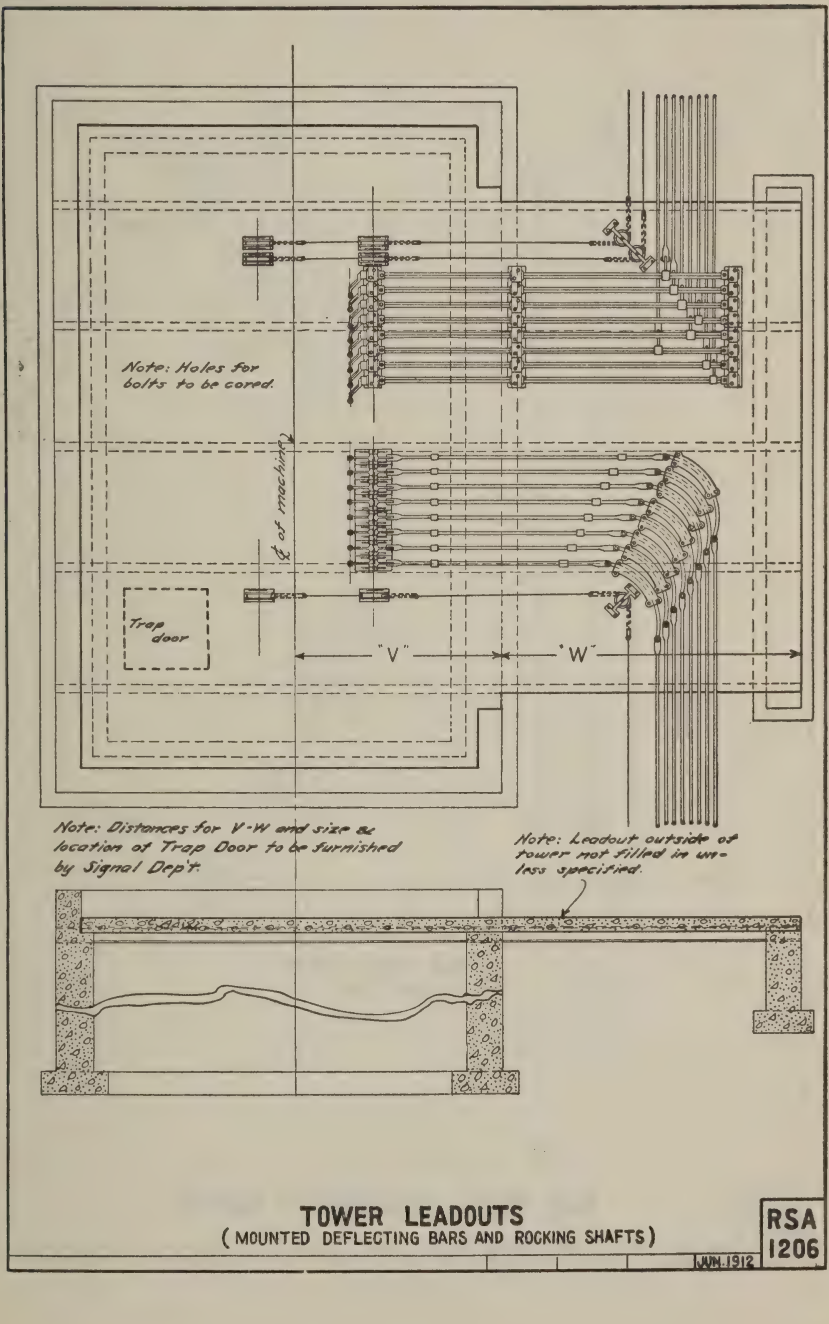

A
3"
$1\frac{1}{2}''$ A
$1\frac{1}{2}''$ A
Y
X
4"
3"
A
B
4"
22" B
$9\frac{1}{2}''$ B
20" B
36" B
$2\frac{1}{8}''$ B
4 PIN CROSS ARM
$17\frac{1}{4}''$ B
19" B
48" B
6 PIN CROSS ARM
$15\frac{1}{2}''$ B
60" B
8 PIN CROSS ARM
$12\frac{3}{8}''$ B
16" B
$2\frac{1}{2}''$
10 PIN CROSS ARM

CROSS ARMS

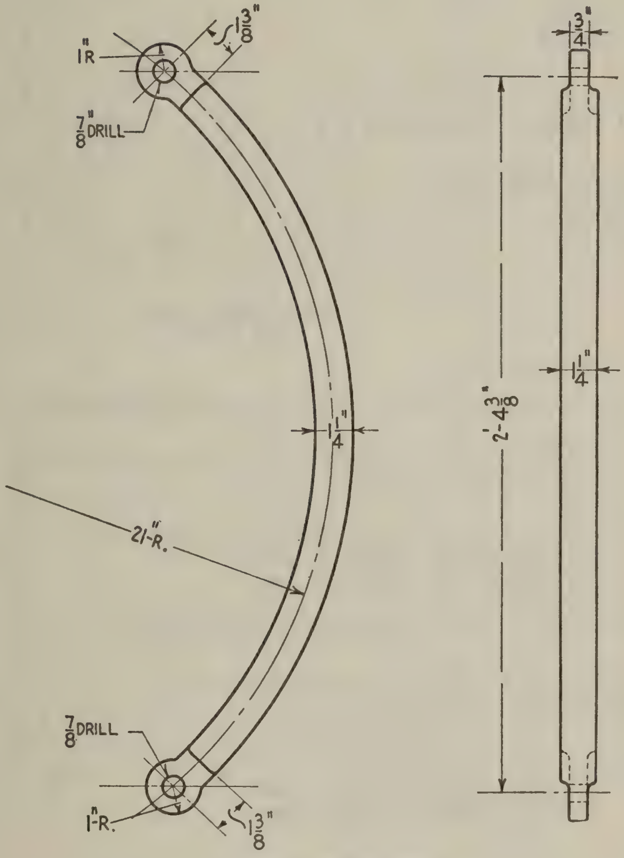
RSA
1089

OCT. 1912 | OCT. 1911

Deflecting Bars and Rocking Shafts Mounted.


Note: Holes for bolts to be cored.
℄ of machine
Trap door
"V"
"W"
Note: Distances for V-W and size & location of Trap Door to be furnished by Signal Dep't.
Note: Leadout outside of tower not filled in unless specified.
TOWER LEADOUTS
(MOUNTED DEFLECTING BARS AND ROCKING SHAFTS)
JUN. 1912
RSA
1206

Deflecting Stand. Bars. Details.


1 3/8"
1" R
7/8" DRILL
1 1/4"
21" R.
2'-4 3/8"
3/4"
1 1/4"
7/8 DRILL
1" R.
1 3/8"

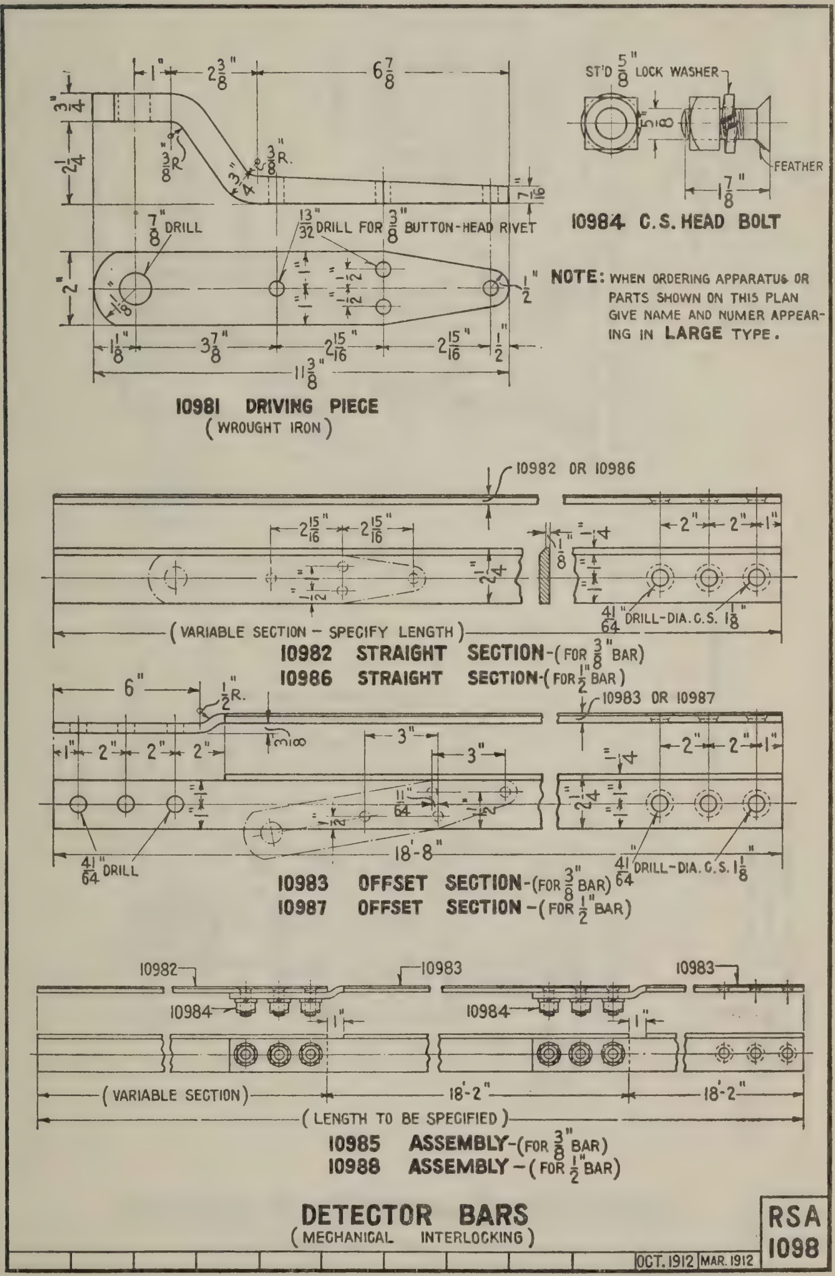
10691 90 DEG. BAR
(O.H. STEEL)

DETAILS OF DEFLECTING STAND BAR

OCT. 1912

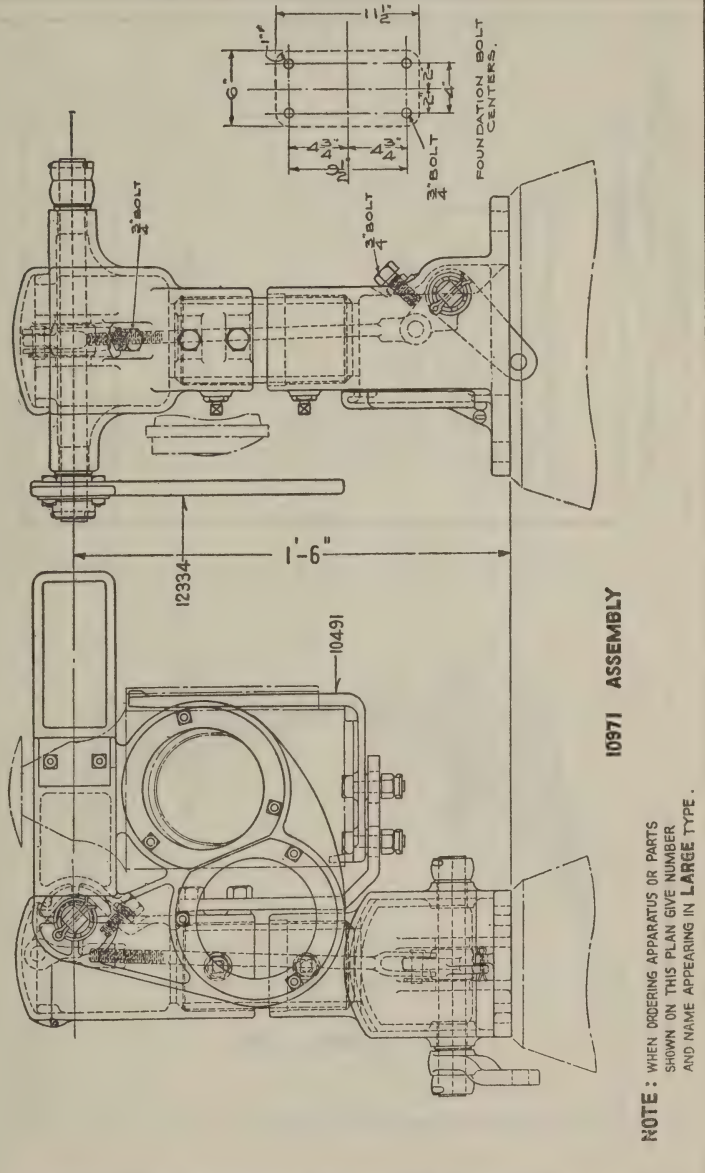
RSA
1069

Detector Bars. Mechanical. Interlocking.


10981 DRIVING PIECE
(WROUGHT IRON)
7/8" DRILL
13/32" DRILL FOR 3/8" BUTTON-HEAD RIVET
1"
2 3/8"
6 7/8"
3/4"
2 1/4"
3/8" R.
7/16"
1 1/8"
3 7/8"
2 15/16"
1/2"
11 3/8"
10984 C.S. HEAD BOLT
ST'D 5/8" LOCK WASHER
FEATHER
1 7/8"
10982 OR 10986
(VARIABLE SECTION – SPECIFY LENGTH)
41/64" DRILL-DIA. C.S. 1 1/8"
10982 STRAIGHT SECTION-(FOR 3/8" BAR)
10986 STRAIGHT SECTION-(FOR 1/2" BAR)
6"
1/2" R.
10983 OR 10987
3"
18'-8"
41/64" DRILL
10983 OFFSET SECTION-(FOR 3/8" BAR)
10987 OFFSET SECTION-(FOR 1/2" BAR)
10982
10983
10984
(VARIABLE SECTION)
18'-2"
(LENGTH TO BE SPECIFIED)
10985 ASSEMBLY-(FOR 3/8" BAR)
10988 ASSEMBLY-(FOR 1/2" BAR)
DETECTOR BARS
(MECHANICAL INTERLOCKING)
RSA
1098
OCT. 1912
MAR. 1912

NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NAME AND NUMER APPEARING IN **LARGE** TYPE.

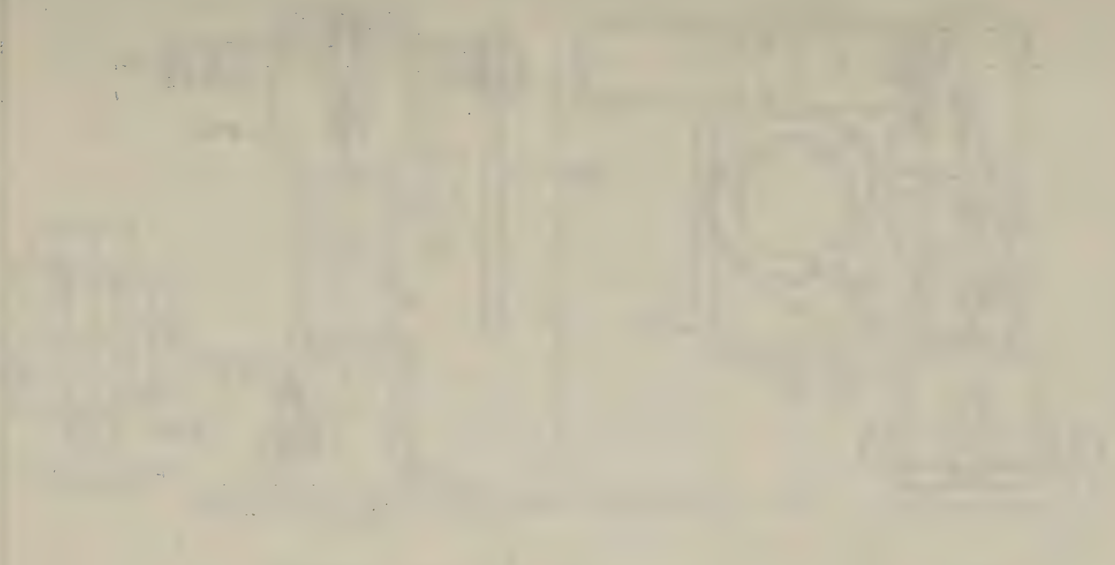
Dwarf Signal. Mechanical. Assembly of.


1'-6"
12334
10491
10971 ASSEMBLY
$\frac{3}{4}$" BOLT
$\frac{3}{4}$" BOLT
$\frac{3}{4}$" BOLT
FOUNDATION BOLT CENTERS.
11$\frac{1}{2}$"
1"
6"
2"
2"
4"
4$\frac{3}{4}$"
4$\frac{3}{4}$"
9$\frac{1}{2}$"
NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN LARGE TYPE.

ASSEMBLY OF MECHANICAL DWARF SIGNAL

RSA
1097

OCT. 1912 OCT. 1911



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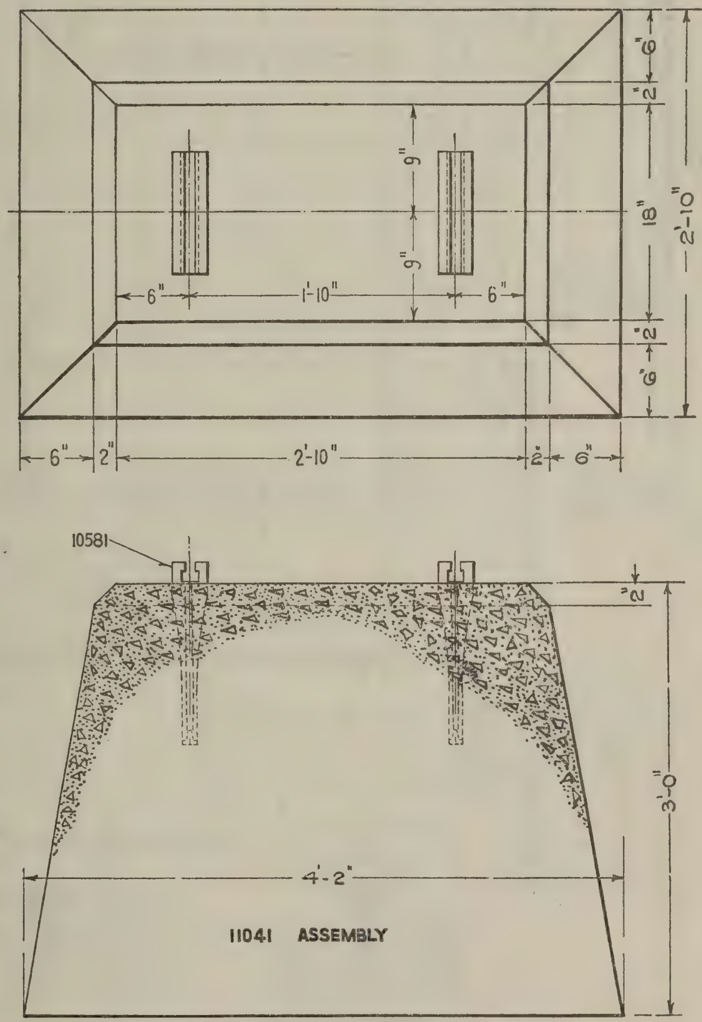
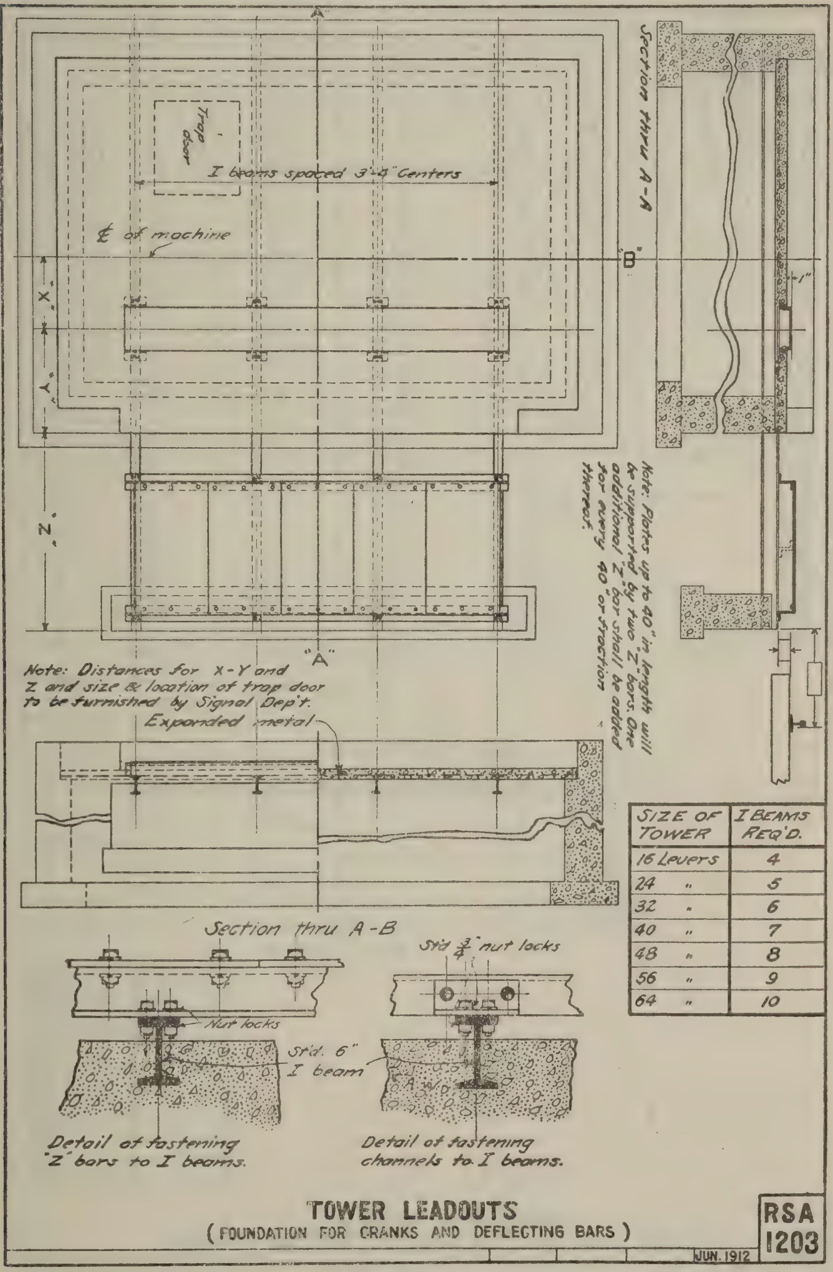
OF THE
UNIVERSITY OF ILLINOIS


6"
2"
18"
2'-10"
9"
9"
2"
6"
6"
1'-10"
6"
6"
2"
2'-10"
2"
6"
10581
2"
3'-0"
4'-2"
11041 ASSEMBLY

FOUNDATION FOR COMPENSATOR.

MANUAL-MAR.1913 OCT.1909

RSA 1104


"A"
Trap door
I beams spaced 3'-4" Centers
℄ of machine
"B"
"X"
"Y"
"Z"
"A"
Section thru A-A
1"
Expanded metal
Section thru A-B
Std ¾" nut locks
Nut locks
Std. 6" I beam

Note: Distances for X-Y and Z and size & location of trap door to be furnished by Signal Dep't.

Note: Plates up to 40" in length will be supported by two "Z" bars. One additional "Z" bar shall be added for every 40" or fraction thereof.

SIZE OF TOWER	I BEAMS REQ'D.
16 Levers	4
24 "	5
32 "	6
40 "	7
48 "	8
56 "	9
64 "	10

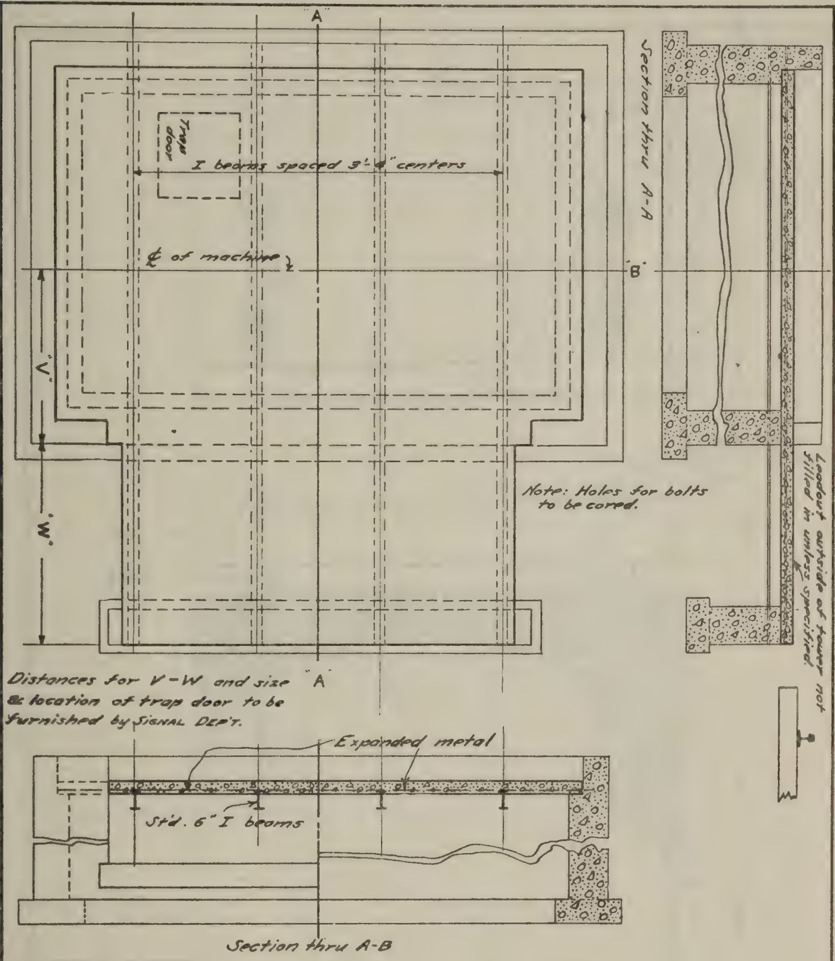
Detail of fastening "Z" bars to I beams.

Detail of fastening channels to I beams.

TOWER LEADOUTS
(FOUNDATION FOR CRANKS AND DEFLECTING BARS)

RSA
1203

JUN. 1912


"A"
Trap door
I beams spaced 3'-4" centers
℄ of machine ℄
"B"
"V"
"W"
"A"
Section thru A-A
Leadout outside of tower not filled in unless specified
Expanded metal
Std. 6" I beams
Section thru A-B

Note: Holes for bolts to be cored.

Distances for V-W and size & location of trap door to be furnished by Signal Dep't.

SIZE OF TOWER	I BEAMS REQ'D.
16 Levers	4
24 "	5
32 "	6
40 "	7
48 "	8
56 "	9
64 "	10

TOWER LEADOUTS

(FOUNDATION FOR CRANK, DEFLECTING BARS AND ROCKING SHAFTS)

OCT. 1912

RSA
1217

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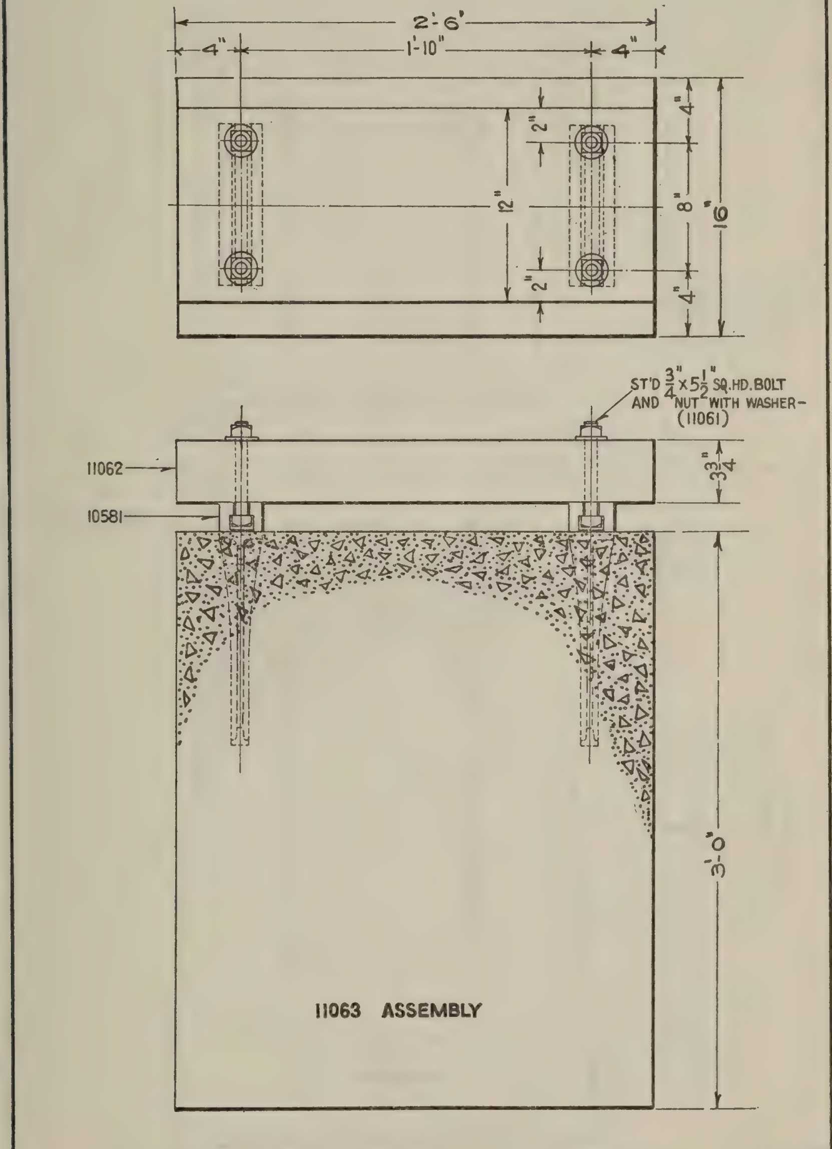
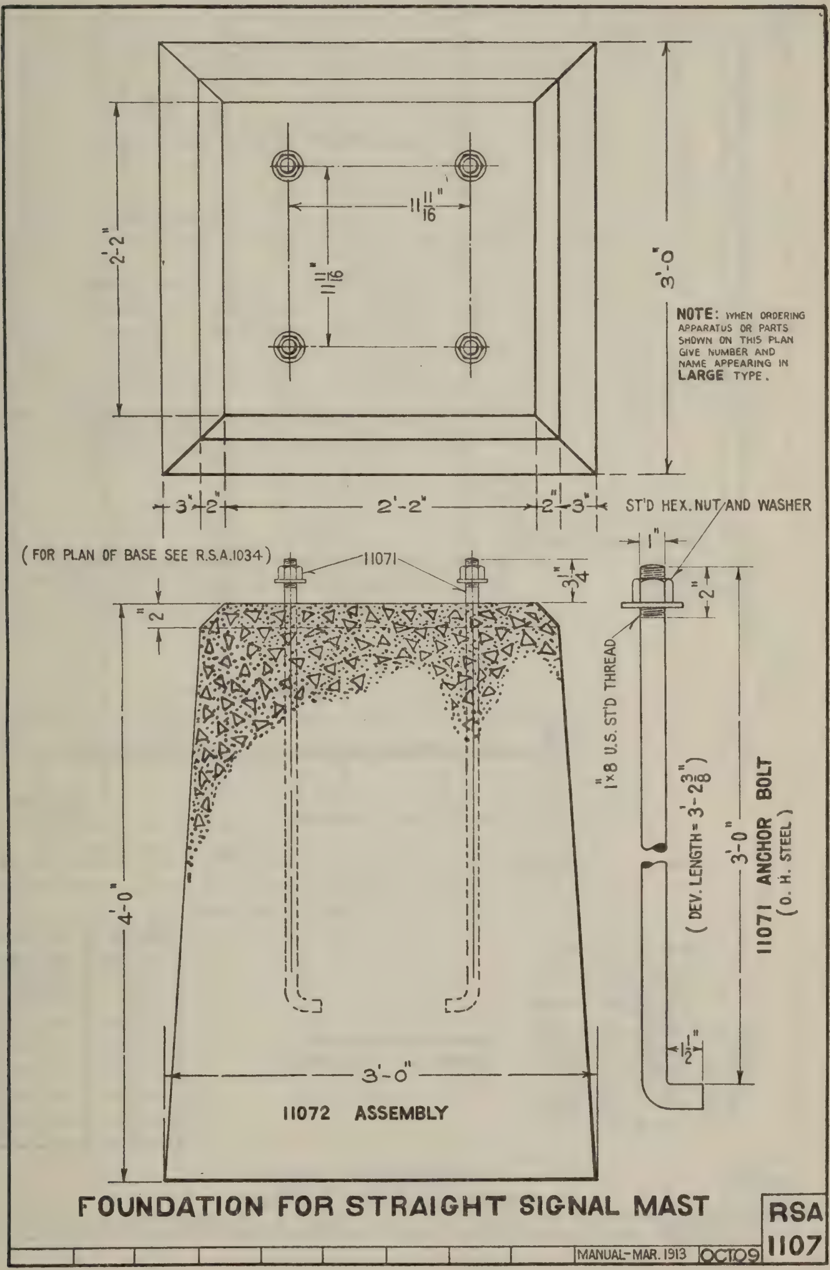
Foundation.
Dwarf
Signal.
Concrete.


2'-6"
4"
1'-10"
4"
2"
12"
2"
4"
8"
4"
16"
ST'D $\frac{3}{4}$" x $5\frac{1}{2}$" SQ.HD.BOLT AND NUT WITH WASHER- (11061)
11062
10581
$3\frac{3}{4}$"
3'-0"
11063 ASSEMBLY

FOUNDATION FOR DWARF SIGNAL.

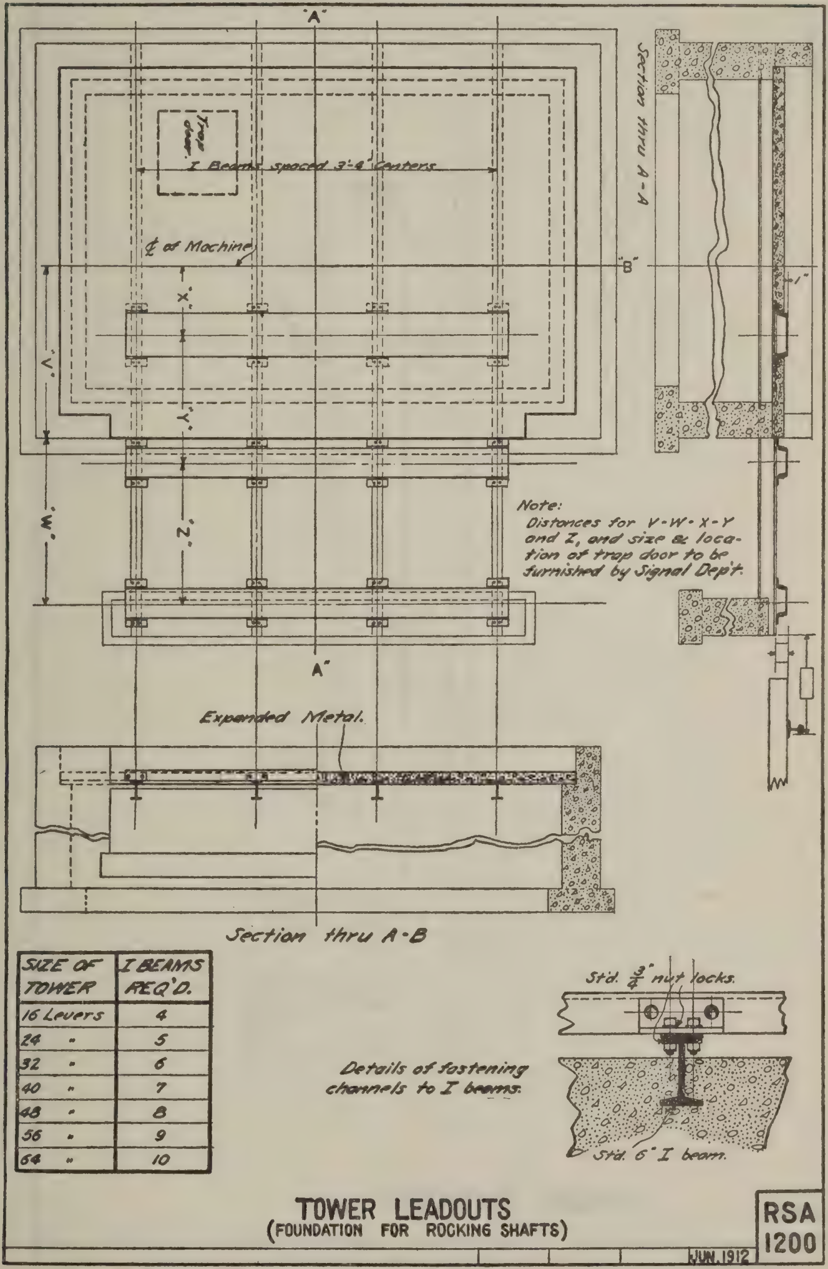
MANUAL-MAR.1913 OCT.09. RSA 1106



FOUNDATION FOR STRAIGHT SIGNAL MAST

2'-2"
11 11/16"
11 11/16"
3'-0"
NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN LARGE TYPE.
3" 2" 2'-2" 2" 3"
ST'D HEX. NUT AND WASHER
(FOR PLAN OF BASE SEE R.S.A. 1034)
11071
3 1/4"
1"
2"
2"
1"×8 U.S. ST'D THREAD
(DEV. LENGTH = 3'-2 3/8")
3'-0"
11071 ANCHOR BOLT
(O. H. STEEL)
4'-0"
1 1/2"
3'-0"
11072 ASSEMBLY
RSA
1107
MANUAL-MAR. 1913
OCT.09

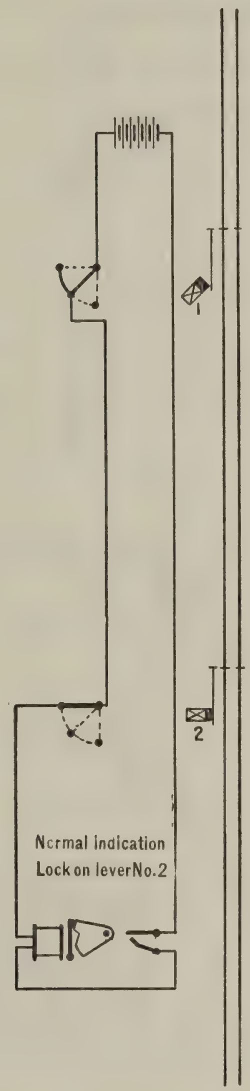
Foundation for Rocking Shafts.


"A"
Trap door.
I Beams spaced 3'-4" Centers.
℄ of Machine
"B"
"X"
"V"
"Y"
"W"
"Z"
"A"
Section thru A-A
1"
Note:
Distances for V-W-X-Y and Z, and size & location of trap door to be furnished by Signal Dep't.
Expanded Metal.
Section thru A-B
Std. ¾" nut locks.
Details of fastening channels to I beams.
Std. 6" I beam.
JUN. 1912

SIZE OF TOWER	I BEAMS REQ'D.
16 Levers	4
24 "	5
32 "	6
40 "	7
48 "	8
56 "	9
64 "	10

TOWER LEADOUTS
(FOUNDATION FOR ROCKING SHAFTS)

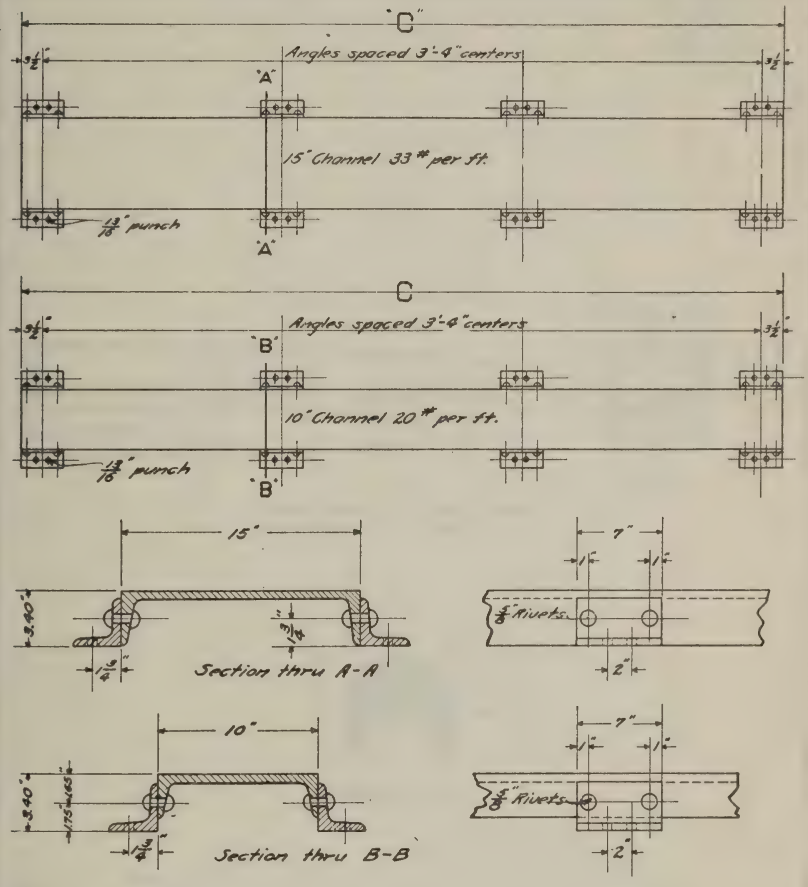
RSA
1200

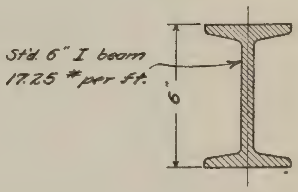

1
2
Normal indication
Lock on lever No.2

INDICATION LOCKING

JUN. 1912

RSA
1173


"C"
$3\frac{1}{2}$"
Angles spaced 3'-4" centers
"A"
15" Channel 33# per ft.
$\frac{13}{16}$" punch
C
"B"
10" Channel 20# per ft.
15"
3.40"
$\frac{3}{4}$"
$1\frac{3}{4}$"
Section thru A-A
7"
1"
$\frac{5}{8}$" Rivets
2"
10"
.175"
.165"
Section thru B-B


Std. 6" I beam
17.25 # per ft.
6"

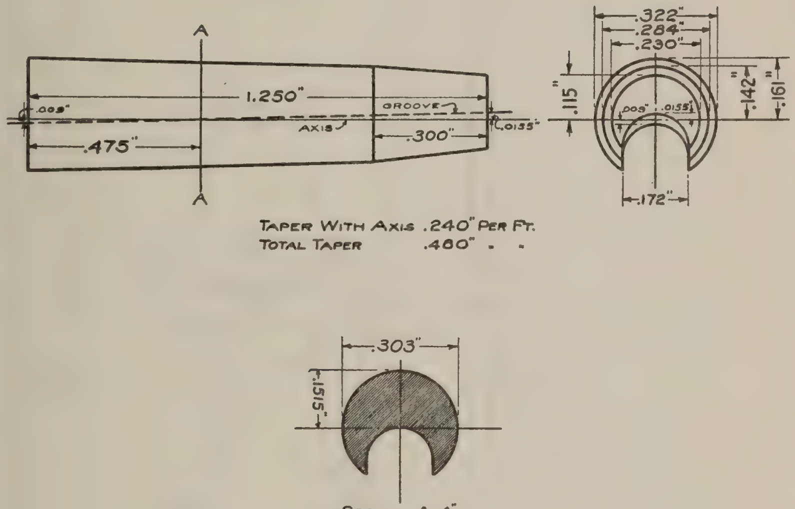
SIZE OF TOWER	"C"	3"x3"x$\frac{3}{8}$" ANGLE
16 Levers	10' - 7"	8, 4 on each side
24 "	13' - 11"	10, 5 "
32 "	17' - 3"	12, 6 "
40 "	20' - 7"	14, 7 "
48 "	23' - 11"	16, 8 "
56 "	27' - 3"	18, 9 "
64 "	30' - 7"	20, 10 "

C.A.W.

DETAILS OF TOWER LEADOUTS
(CHANNELS AND I-BEAMS)

JUN. 1912

RSA
1202


A
A
1.250"
.005"
.475"
GROOVE
AXIS
.300"
.0155"
.322"
.284"
.230"
.115"
.142"
.161"
.005"
.0155"
.172"
.303"
.1515"

SECTION A-A".

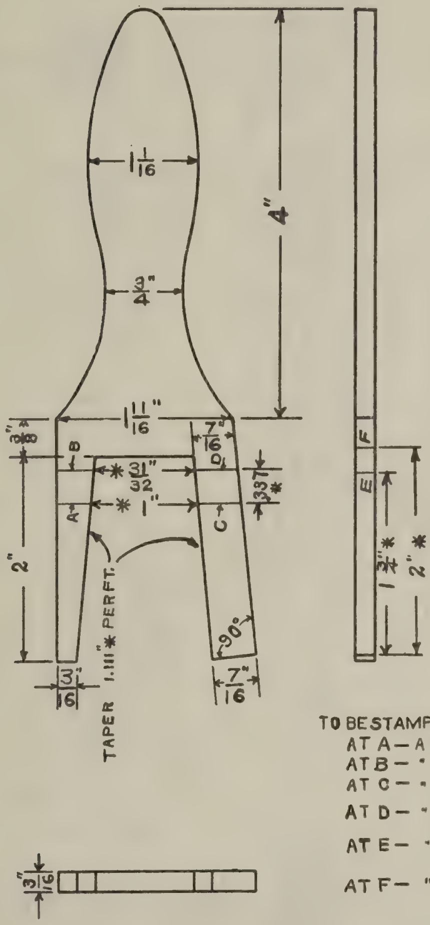
TAPER WITH AXIS .240" PER FT.
TOTAL TAPER .480" " "

Note:-
Allowable Maximum and Minimum variation in diameter to be three one-thousandths (.003) inch.
Ends of Pin to be at Right Angles to Axis.
Dimensions as shown are with plating applied.

CHANNEL PIN

RSA
1086

OCT.1912 | MAR.1912 | DEC.1910 | OCT.1910


1 1/16
4"
3/4"
1 11/16"
3/8"
7/16"
B
D
*31/32"
*1"
33/1000"*
A
C
2"
TAPER 1.111"* PERFT.
90°
3/16"
7/16"
F
E
1 3/4"*
2"*
3/16"

TO BE STAMPED AS FOLLOWS:—
AT A — A LINE
AT B — " "
AT C — " " MARKED 1"
AT D — " " " $\frac{31}{32}$"
AT E — " " " 1$\frac{3}{4}$"
AT F — " " " 2"

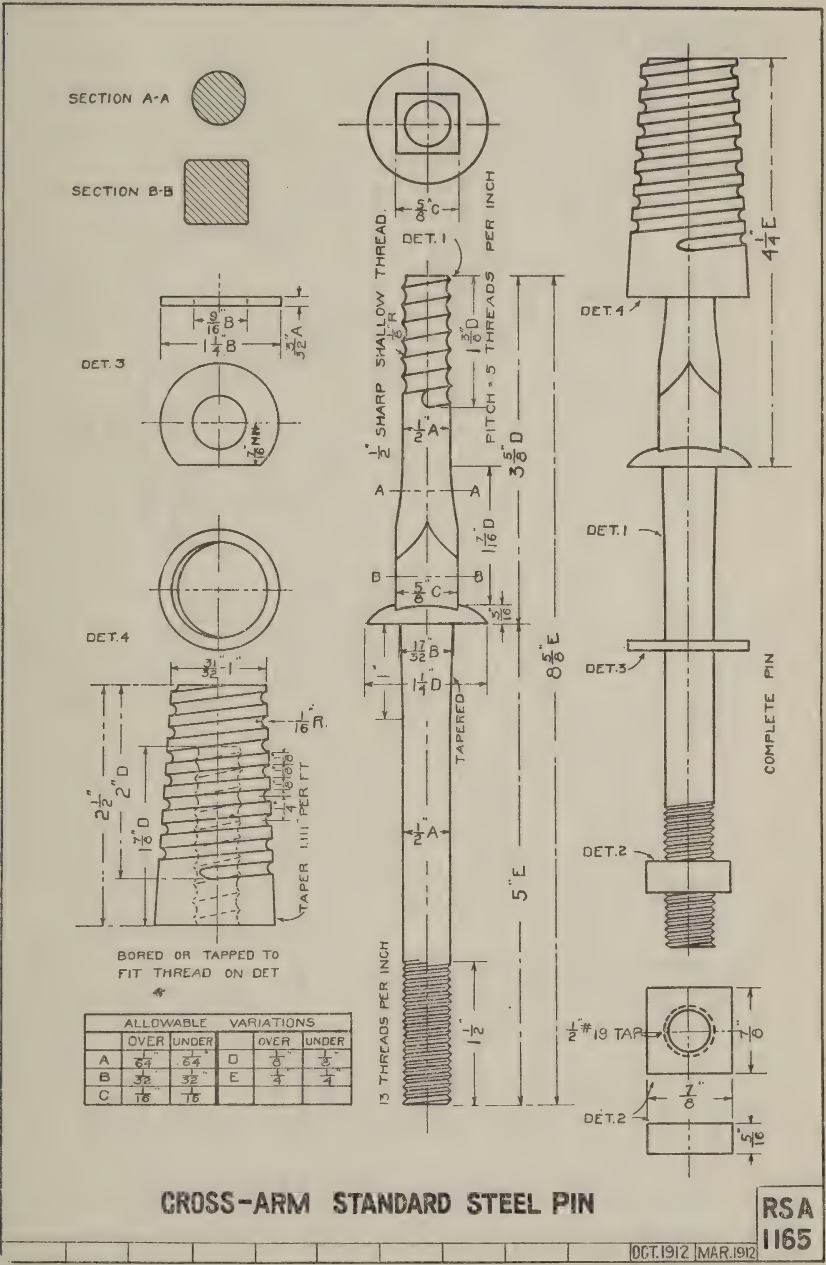
NOTE:— DIMENSIONS MARKED * MUST BE CORRECT WITHIN 0.005"
ALL OTHER DIMENSIONS ARE APPROXIMATE.

CROSS-ARM PIN CAP GAUGE
(HARDENED STEEL)

MAR. 1912

RSA
1167

Pin—Steel.
Crossarm.
Standard.


SECTION A-A
SECTION B-B
DET. 3
$\frac{9}{16}$" B
$1\frac{1}{4}$" B
$\frac{3}{32}$" A
$\frac{7}{16}$" MIN.
DET. 4
$\frac{31}{32}$"-1"
$\frac{1}{16}$" R.
$2\frac{1}{2}$"
2" D
$1\frac{7}{8}$" D
$1\frac{1}{4}$" $1\frac{1}{8}$" $1\frac{1}{8}$"
TAPER 1.111" PER FT
BORED OR TAPPED TO FIT THREAD ON DET 4
$\frac{5}{8}$" C
DET. 1
$\frac{1}{2}$" SHARP SHALLOW THREAD.
$\frac{1}{8}$" R
$1\frac{3}{8}$" D
PITCH - 5 THREADS PER INCH
$\frac{1}{2}$" A
A
A
$3\frac{5}{8}$" D
$1\frac{7}{16}$" D
B
B
$\frac{5}{8}$" C
$\frac{5}{16}$"
$\frac{17}{32}$" B
1"
$1\frac{1}{4}$" D
TAPERED
$8\frac{5}{8}$" E
$\frac{1}{2}$" A
5" E
13 THREADS PER INCH
$1\frac{1}{2}$"
DET. 4
$4\frac{1}{4}$" E
DET. 1
DET. 3
COMPLETE PIN
DET. 2
$\frac{1}{2}$" #19 TAP
$\frac{7}{8}$"
$\frac{7}{8}$"
DET. 2
$\frac{5}{16}$"

ALLOWABLE VARIATIONS					
	OVER	UNDER		OVER	UNDER
A	$\frac{1}{64}$"	$\frac{1}{64}$"	D	$\frac{1}{8}$"	$\frac{1}{8}$"
B	$\frac{1}{32}$"	$\frac{1}{32}$"	E	$\frac{1}{4}$"	$\frac{1}{4}$"
C	$\frac{1}{16}$"	$\frac{1}{16}$"			

CROSS-ARM STANDARD STEEL PIN

OCT. 1912 MAR. 1912

RSA 1165

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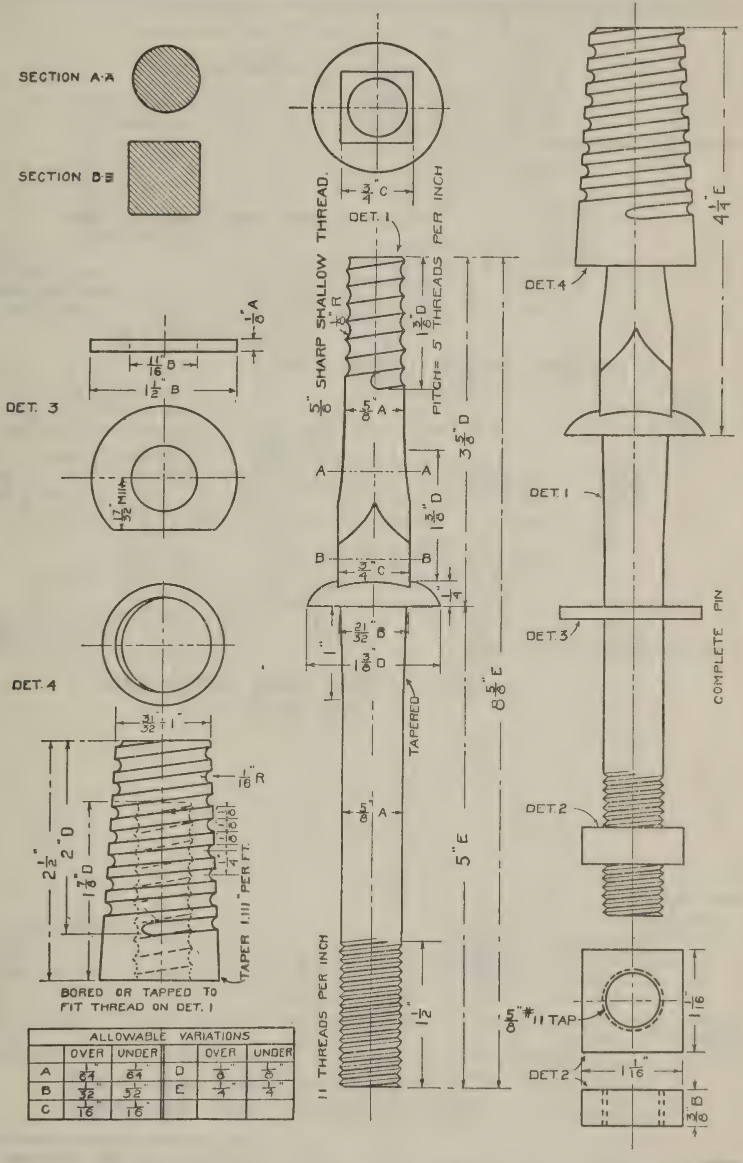
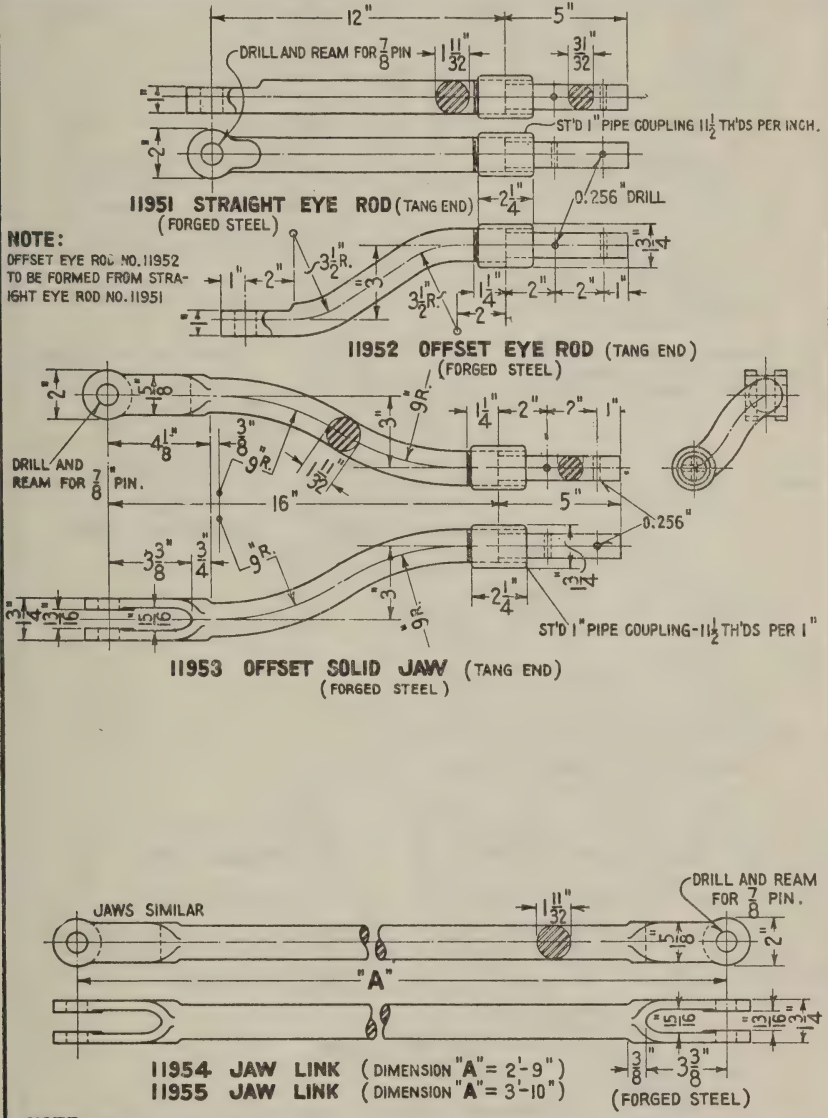

SECTION A-A
SECTION B-B
DET. 3
1/8" A
11/16" B
1 1/2" B
17/32" MIN.
DET. 4
31/32 ± 1"
1/16" R
2 1/2"
2" D
1 7/8" D
1/4" 1/8 1/8 1/8
TAPER 1.111" PER FT.
BORED OR TAPPED TO FIT THREAD ON DET. 1
3/4" C
DET. 1
5/8" SHARP SHALLOW THREAD.
1/8" R
1 3/8" D
PITCH = 5 THREADS PER INCH
5/8" A
A
B
3 5/8" D
1 3/8" D
3/4" C
1/4"
21/32" B
1"
1 3/8" D
TAPERED
8 5/8" E
5/8" A
5" E
11 THREADS PER INCH
1 1/2"
DET. 4
4 1/4" E
DET. 1
DET. 3
COMPLETE PIN
DET. 2
5/8" #11 TAP
1 1/16"
DET. 2
1 1/16"
3/8" B

ALLOWABLE VARIATIONS					
	OVER	UNDER		OVER	UNDER
A	1/64"	1/64"	D	1/8"	1/8"
B	1/32"	1/32"	E	1/4"	1/4"
C	1/16"	1/16"			

CROSS-ARM STEEL TERMINAL PIN

RSA 1166

OCT. 1912 MAR. 1912


12"
5"
DRILL AND REAM FOR 7/8 PIN
1 11/32"
31/32"
ST'D 1" PIPE COUPLING 11½ TH'DS PER INCH.
2"
2¼"
0.256" DRILL
11951 STRAIGHT EYE ROD (TANG END)
(FORGED STEEL)
NOTE:
OFFSET EYE ROD NO. 11952 TO BE FORMED FROM STRAIGHT EYE ROD NO. 11951
3½"R.
=3"
1"
2"
3/4"
1¼"
2"
2"
1"
3½"R.
2
11952 OFFSET EYE ROD (TANG END)
(FORGED STEEL)
2"
5/8"
4⅛"
3/8"
9"R.
3"
9"R.
1 11/32"
1¼"
2"
2"
1"
DRILL AND REAM FOR 7/8" PIN.
16"
5"
0.256"
3⅜"
3/4"
9"R.
3"
9"R.
3/4"
3/16
15/16
2¼"
3/4"
ST'D 1" PIPE COUPLING-11½ TH'DS PER 1"
11953 OFFSET SOLID JAW (TANG END)
(FORGED STEEL)
JAWS SIMILAR
1 11/32"
DRILL AND REAM FOR 7/8 PIN.
5/8"
2"
"A"
15/16
3/16
3/4
3/8"
3⅜"
11954 JAW LINK (DIMENSION "A" = 2'-9")
11955 JAW LINK (DIMENSION "A" = 3'-10")
(FORGED STEEL)

NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NAME AND NUMBER APPEARING IN **LARGE** TYPE.

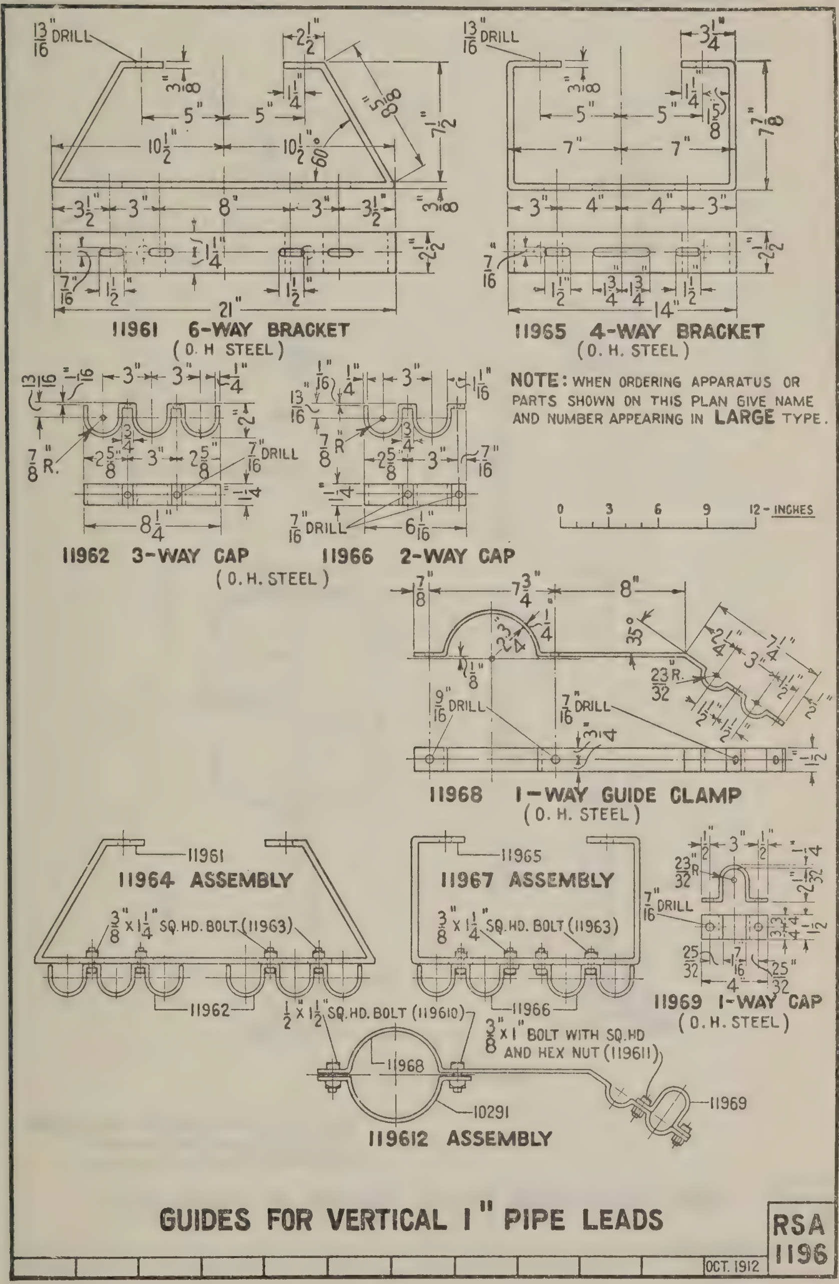
0 1 2 3 4 5 6 - INCHES

1" PIPE OPERATING FITTINGS

RSA
1195

OCT. 1912

Pipe Leads.
One-inch.
Vertical.
Guides for.


11961 6-WAY BRACKET
(O. H STEEL)
13/16" DRILL
21"
11965 4-WAY BRACKET
(O. H. STEEL)
14"
11962 3-WAY CAP
11966 2-WAY CAP
(O. H. STEEL)
7/16" DRILL
7/8" R.
0 3 6 9 12 - INCHES
11968 1-WAY GUIDE CLAMP
(O. H. STEEL)
9/16" DRILL
23/32" R.
35°
11964 ASSEMBLY
11961
11962
3/8" x 1 1/4" SQ. HD. BOLT (11963)
11967 ASSEMBLY
11965
11966
11969 1-WAY CAP
(O. H. STEEL)
1/2" x 1 1/2" SQ. HD. BOLT (119610)
3/8" x 1" BOLT WITH SQ. HD AND HEX NUT (119611)
11968
10291
11969
119612 ASSEMBLY
OCT. 1912

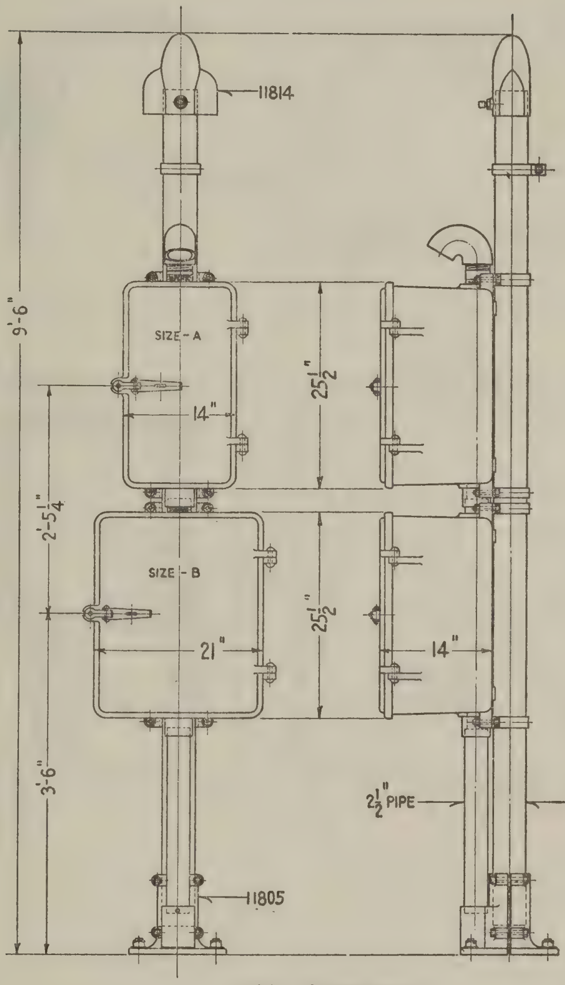
NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NAME AND NUMBER APPEARING IN **LARGE** TYPE.

GUIDES FOR VERTICAL 1" PIPE LEADS

RSA
1196

UNIVERSITY OF ILLINOIS

Relay Boxes.
Cable Posts.
Assembly of.


11814
9'-6"
SIZE - A
14"
25½"
2'-5¼"
SIZE - B
21"
25½"
14"
3'-6"
2½" PIPE
3½" PIPE
11805

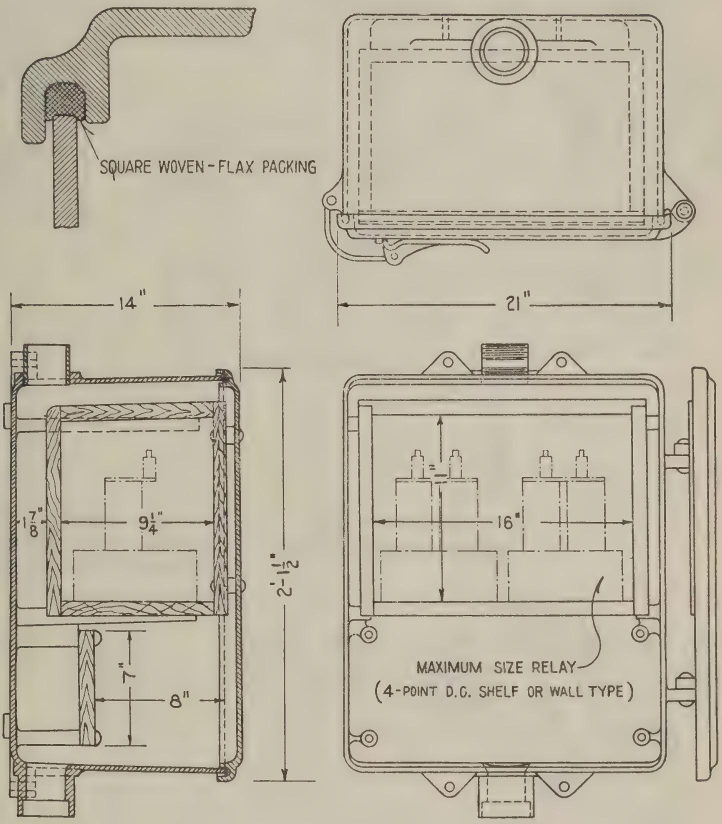
11851 ASSEMBLY

NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE

ASSEMBLY OF RELAY BOXES AND CABLE POST

RSA
1185

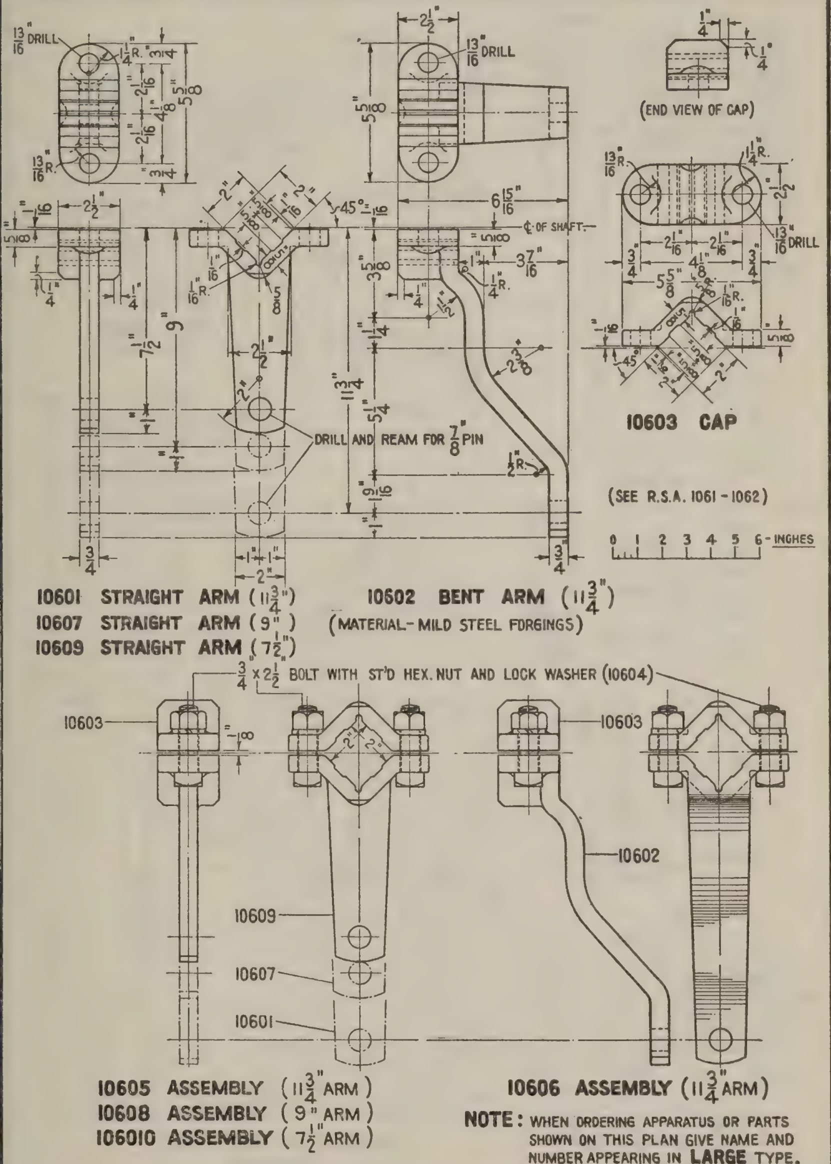
OCT. 1912 JUN. 1912


SQUARE WOVEN-FLAX PACKING
14"
21"
$1\frac{7}{8}$"
$9\frac{1}{4}$"
$2'\text{-}1\frac{1}{2}$"
7"
8"
16"
MAXIMUM SIZE RELAY
(4-POINT D.C. SHELF OR WALL TYPE)

CAST IRON RELAY BOX
SIZE—B

RSA
1182

OCT. 1912 JUN. 1912


13/16" DRILL
13/16" R.
1 1/4" R.
2 1/2"
13/16" DRILL
6 15/16"
3 7/16"
(END VIEW OF CAP)
13/16" DRILL
45°
℄ OF SHAFT
DRILL AND REAM FOR 7/8" PIN
(SEE R.S.A. 1061 - 1062)
0 1 2 3 4 5 6 - INCHES
3/4" x 2 1/2" BOLT WITH ST'D HEX. NUT AND LOCK WASHER (10604)
10603
10602
10609
10607
10601

10601 STRAIGHT ARM (11 3/4")
10607 STRAIGHT ARM (9")
10609 STRAIGHT ARM (7 1/2")

10602 BENT ARM (11 3/4")
(MATERIAL- MILD STEEL FORGINGS)

10603 CAP

10605 ASSEMBLY (11 3/4" ARM)
10608 ASSEMBLY (9" ARM)
106010 ASSEMBLY (7 1/2" ARM)

10606 ASSEMBLY (11 3/4" ARM)

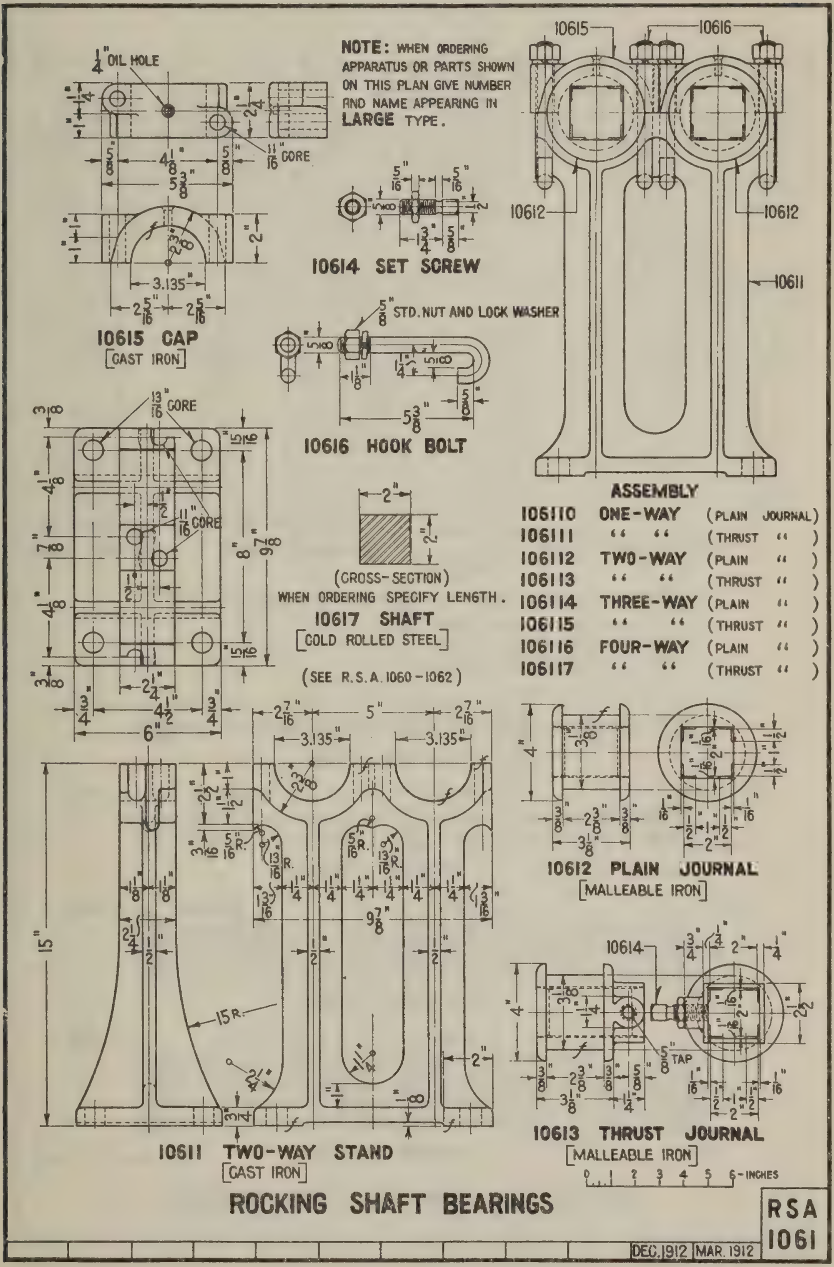
NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NAME AND NUMBER APPEARING IN **LARGE** TYPE.

ROCKING SHAFT ARMS

RSA
1060

OCT. 1912 | MAR. 1912

Rocking.
Shaft
Bearings


1/4" OIL HOLE
11/16" CORE
4 1/8"
5 3/8"
5/8"
2 3/8"
3.135"
2 5/16"
13/16" CORE
11/16" CORE
4 1/8"
7/8"
8"
9 7/8"
15/16"
3/8"
2 1/4"
4 1/2"
3/4"
6"
5/16"
1 3/4"
5/8" STD. NUT AND LOCK WASHER
1 1/8"
5 3/8"
2"
10615
10616
10612
10611
2 7/16"
5"
3.135"
2 3/8"
15"
15 R.
9 7/8"
1 1/4"
1/2"
2 1/4"
3/4"
13/16 R.
5/16 R.
4"
3 1/8"
2 3/8"
10614
5/8" TAP
2 1/2"
0 1 2 3 4 5 6 - INCHES

NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE.

10615 CAP
[CAST IRON]

10614 SET SCREW

10616 HOOK BOLT

(CROSS-SECTION)
WHEN ORDERING SPECIFY LENGTH.
10617 SHAFT
[COLD ROLLED STEEL]

(SEE R.S.A. 1060 - 1062)

ASSEMBLY

106110	**ONE-WAY**	(PLAIN JOURNAL)
106111	" "	(THRUST ")
106112	**TWO-WAY**	(PLAIN ")
106113	" "	(THRUST ")
106114	**THREE-WAY**	(PLAIN ")
106115	" "	(THRUST ")
106116	**FOUR-WAY**	(PLAIN ")
106117	" "	(THRUST ")

10612 PLAIN JOURNAL
[MALLEABLE IRON]

10613 THRUST JOURNAL
[MALLEABLE IRON]

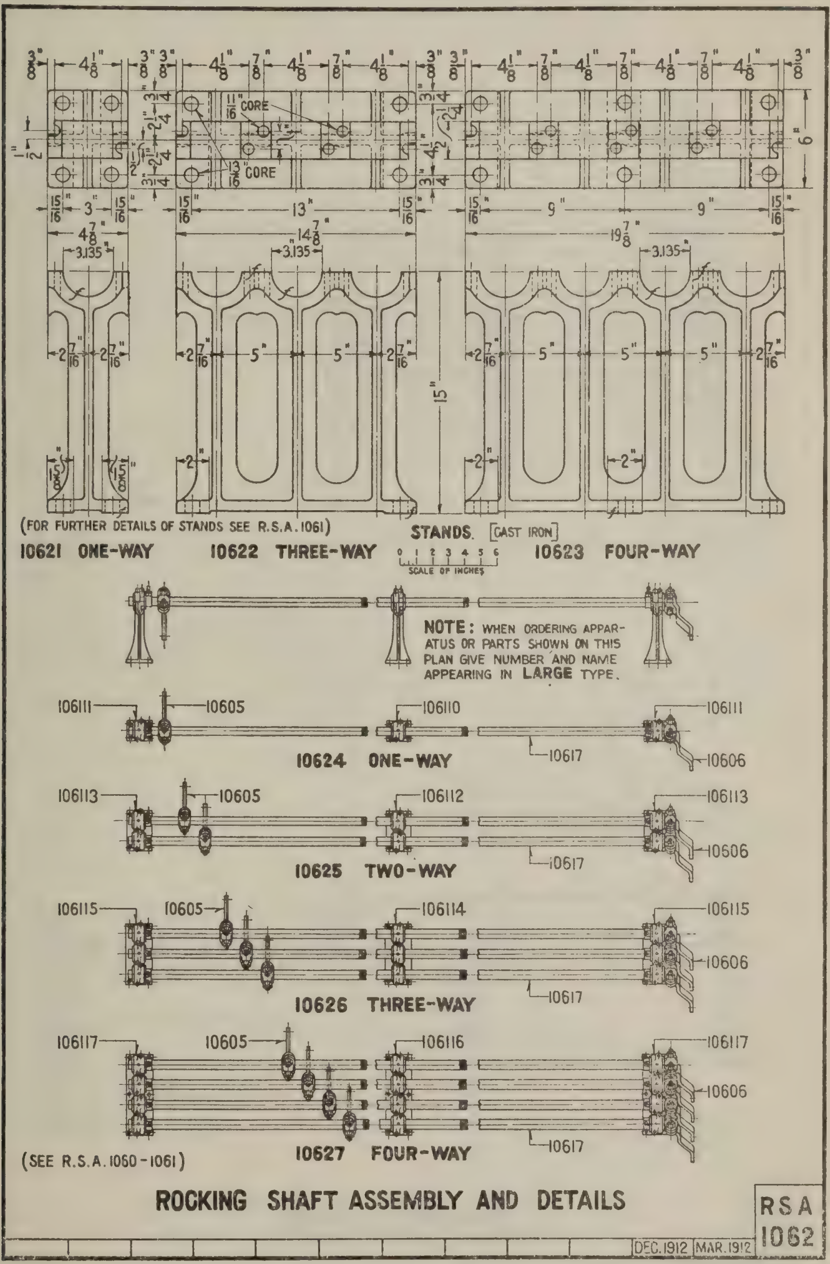
10611 TWO-WAY STAND
[CAST IRON]

ROCKING SHAFT BEARINGS

RSA
1061

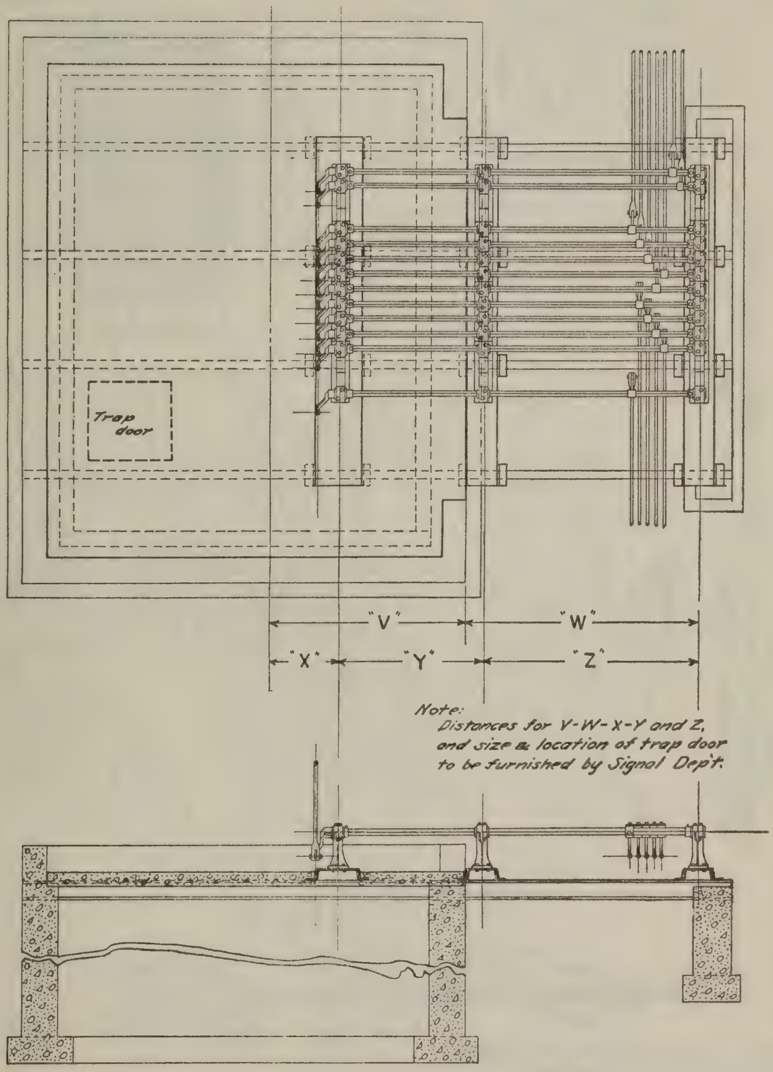
DEC. 1912 MAR. 1912

LIBRARY


(FOR FURTHER DETAILS OF STANDS SEE R.S.A. 1061)
11/16" CORE
13/16" CORE
10621 ONE-WAY
10622 THREE-WAY
10623 FOUR-WAY
STANDS. [CAST IRON]
SCALE OF INCHES
106111
10605
106110
10617
10606
10624 ONE-WAY
106113
106112
10625 TWO-WAY
106115
106114
10626 THREE-WAY
106117
106116
10627 FOUR-WAY
(SEE R.S.A. 1060 - 1061)
DEC. 1912
MAR. 1912
RSA 1062

NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE.

ROCKING SHAFT ASSEMBLY AND DETAILS



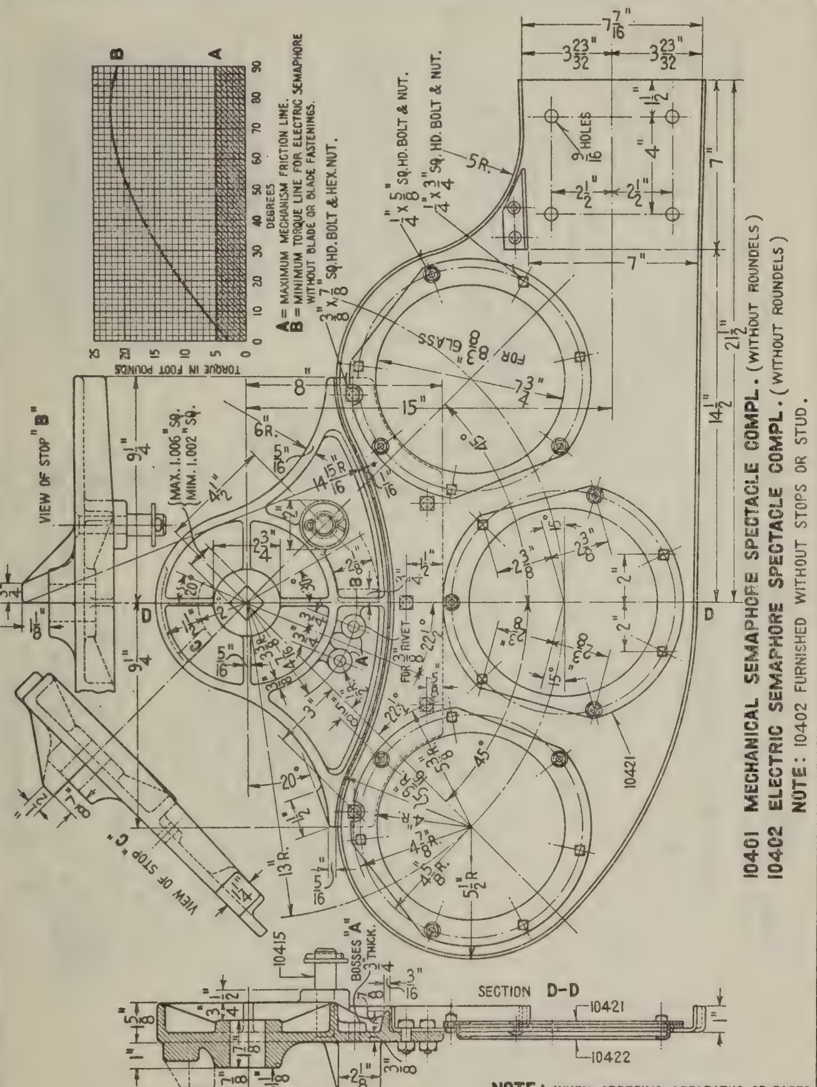
Note:
Distances for V-W-X-Y and Z,
and size & location of trap door
to be furnished by Signal Dep't.

TOWER LEADOUTS
(MOUNTED ROCKING SHAFTS)

JUN. 1912

RSA
1201

LIBRARY
OF THE
UNIVERSITY OF ILLINOIS


TORQUE IN FOOT POUNDS
DEGREES
A = MAXIMUM MECHANISM FRICTION LINE.
B = MINIMUM TORQUE LINE FOR ELECTRIC SEMAPHORE WITHOUT BLADE OR BLADE FASTENINGS.
VIEW OF STOP "B"
VIEW OF STOP "C"
MAX. 1.006" SQ.
MIN. 1.002" SQ.
3/8" x 7/8" SQ. HD. BOLT & HEX. NUT.
1/4" x 5/8" SQ. HD. BOLT & NUT.
1/4" x 3/4" SQ. HD. BOLT & NUT.
9/16 HOLES
FOR 8 3/8" GLASS
FOR 3/8" RIVET
BOSSES "A" 3/4" THICK.
SECTION D-D
10415
10421
10422
D
D

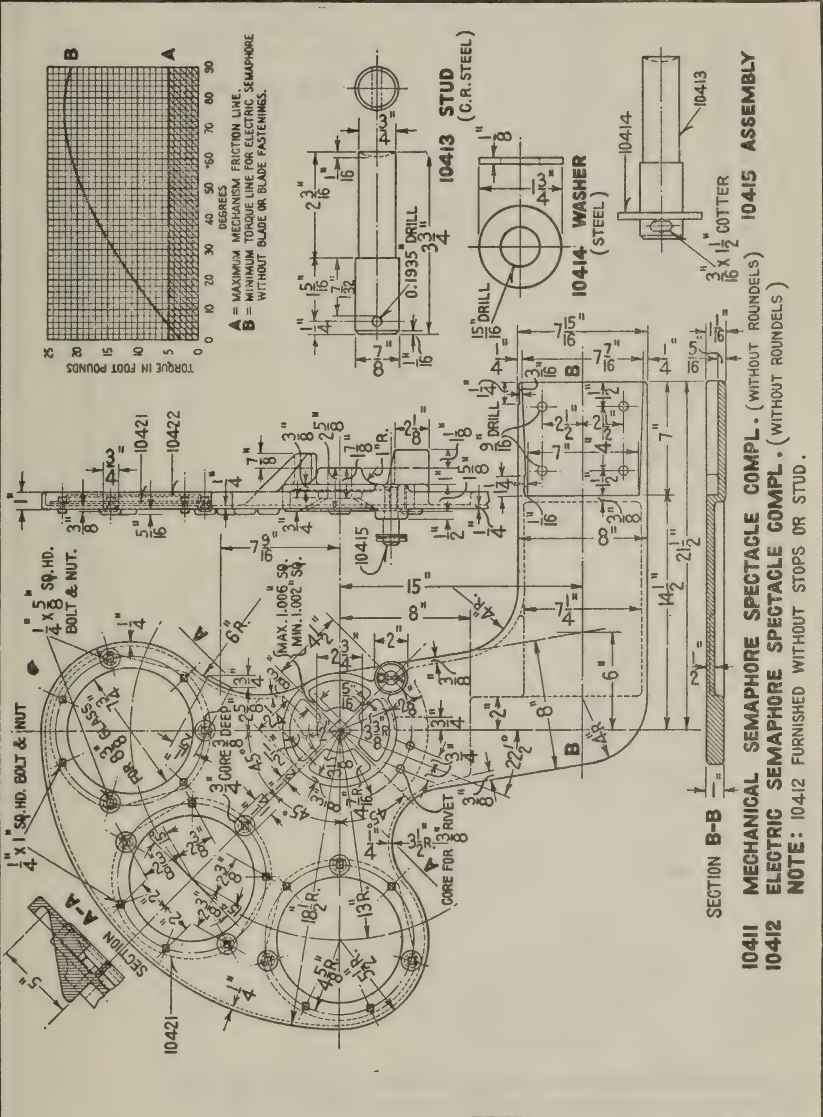
10401 **MECHANICAL SEMAPHORE SPECTACLE COMPL.** (WITHOUT ROUNDELS)
10402 **ELECTRIC SEMAPHORE SPECTACLE COMPL.** (WITHOUT ROUNDELS)
NOTE: 10402 FURNISHED WITHOUT STOPS OR STUD.

NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE

SEMAPHORE SPECTACLE—DESIGN "A"

RSA
1040

OCT. 1912 | OCT. 1911 | OCT. 1909



TORQUE IN FOOT POUNDS
25 20 15 10 5 0
0 10 20 30 40 50 60 70 80 90
DEGREES
A
B
A = MAXIMUM MECHANISM FRICTION LINE.
B = MINIMUM TORQUE LINE FOR ELECTRIC SEMAPHORE WITHOUT BLADE OR BLADE FASTENINGS.
10413 STUD (C.R. STEEL)
0.1935" DRILL
10414 WASHER (STEEL)
15/16" DRILL
10415 ASSEMBLY
10413
10414
3/16" x 1 1/2" COTTER
10421
10422
10415
1/4" x 5/8" SQ. HD. BOLT & NUT.
1/4" x 1" SQ. HD. BOLT & INUT
8 3/8" GLASS
8 7/8" DIA.
6" R.
MAX. 1.006" SQ.
MIN. 1.002" SQ.
CORE 3/4" DEEP
CORE FOR 3/8" RIVET
9/16" DRILL
SECTION A-A
SECTION B-B
B
A
10421
10411 MECHANICAL SEMAPHORE SPECTACLE COMPL. (WITHOUT ROUNDELS)
10412 ELECTRIC SEMAPHORE SPECTACLE COMPL. (WITHOUT ROUNDELS)
NOTE: 10412 FURNISHED WITHOUT STOPS OR STUD.

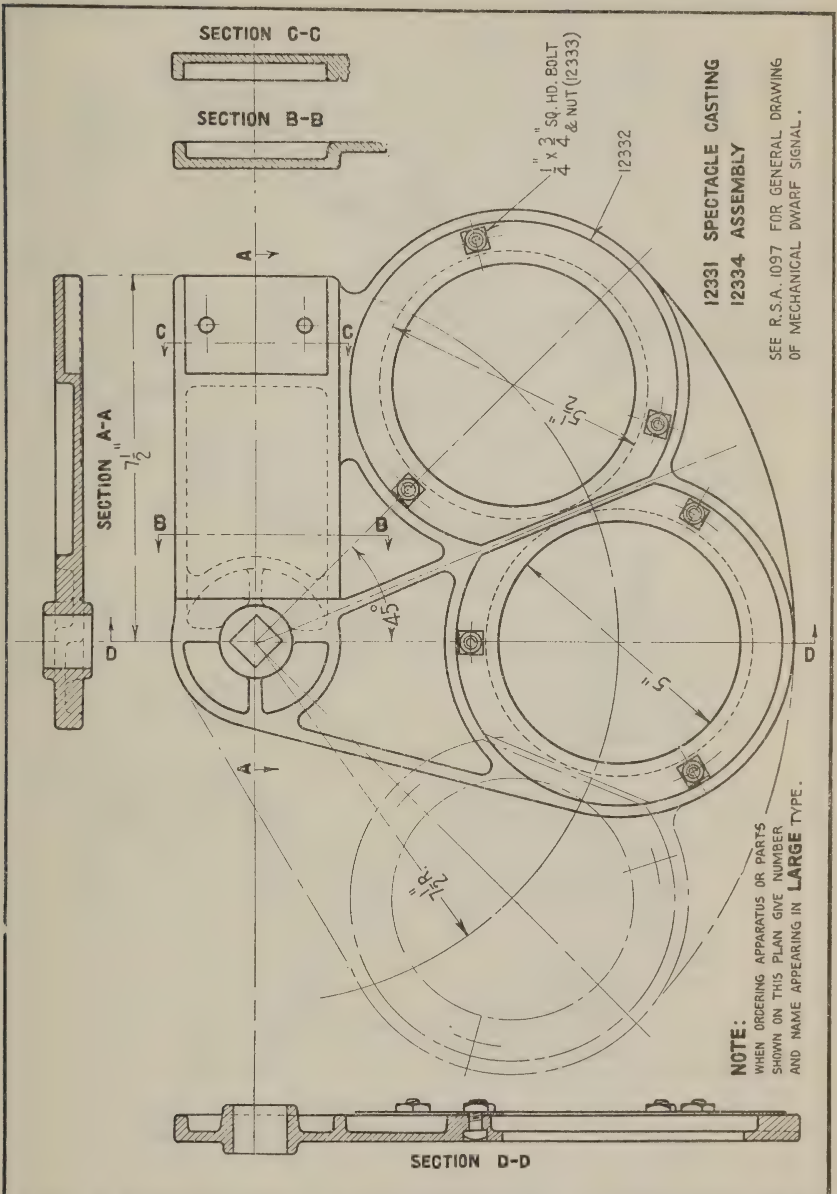
NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE.

SEMAPHORE SPECTACLE—DESIGN "B"

OCT.1912 OCT.1911 OCT.1909

RSA 1041

LIBRARY
UNIVERSITY OF ILLINOIS


SECTION C-C
SECTION B-B
$\frac{1}{4}$" x $\frac{3}{4}$" SQ. HD. BOLT & NUT (12333)
12332
12331 SPECTACLE CASTING
12334 ASSEMBLY
SEE R.S.A. 1097 FOR GENERAL DRAWING OF MECHANICAL DWARF SIGNAL.
A
C
C
SECTION A-A
$7\frac{1}{2}$"
$5\frac{3}{4}$"
B
B
45°
D
D
5"
A
$7\frac{1}{2}$"R.
SECTION D-D

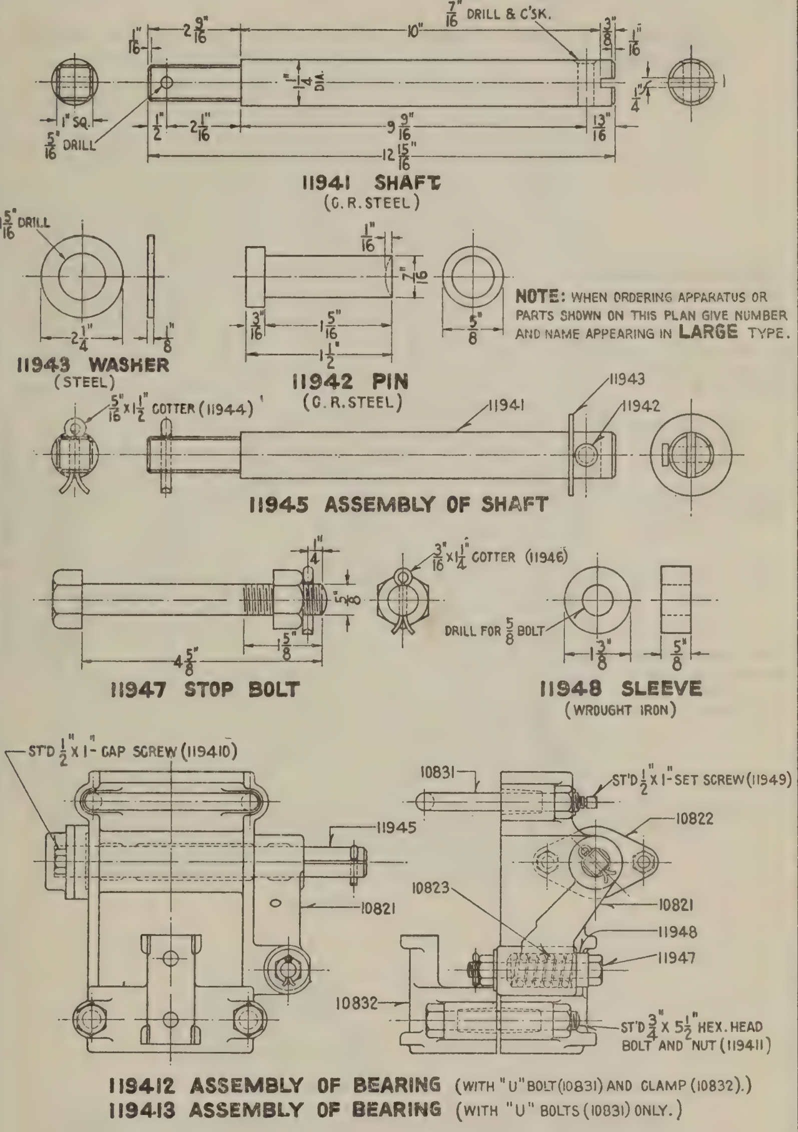
NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE.

2-POSITION—UPPER QUADRANT DWARF SPECTACLE

RSA 1233

OCT. 1912

Semaphore
Bearing.
Mechanical.
Details.


7/16" DRILL & C'SK.
1/16"
2 9/16"
10"
3/8"
1/16"
1 1/4" DIA.
1"
1/4"
1" SQ.
5/16" DRILL
1/2"
2 1/16"
9 9/16"
13/16"
12 15/16"
11941 SHAFT
(C.R. STEEL)
1 5/16" DRILL
2 1/4"
1/8"
11943 WASHER
(STEEL)
1/16"
7/16"
3/16"
1 5/16"
1 1/2"
5/8"
11942 PIN
(C.R. STEEL)
5/16" x 1 1/2" COTTER (11944)
11941
11943
11942
11945 ASSEMBLY OF SHAFT
1/4"
5/8"
1 5/8"
4 5/8"
3/16" x 1 1/4" COTTER (11946)
11947 STOP BOLT
DRILL FOR 5/8 BOLT
1 3/8"
5/8"
11948 SLEEVE
(WROUGHT IRON)
ST'D 1/2" x 1" CAP SCREW (119410)
11945
10821
10831
ST'D 1/2" x 1" SET SCREW (11949)
10822
10823
10821
11948
11947
10832
ST'D 3/4" x 5 1/2" HEX. HEAD BOLT AND NUT (119411)
119412 ASSEMBLY OF BEARING (WITH "U" BOLT (10831) AND CLAMP (10832).)
119413 ASSEMBLY OF BEARING (WITH "U" BOLTS (10831) ONLY.)

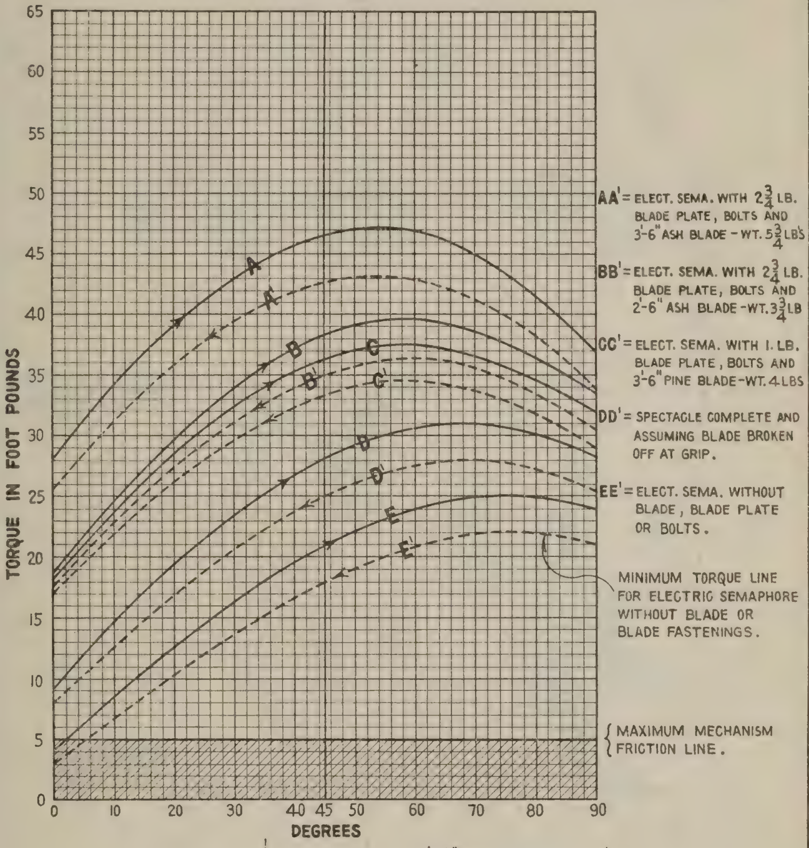
NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE.

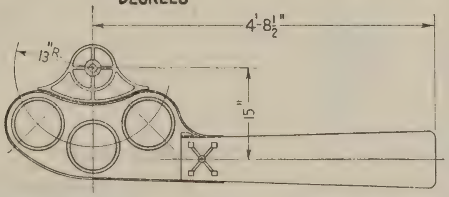
DETAILS AND ASSEMBLY OF MECHANICAL SEMAPHORE BEARING

RSA
1194

OCT. 1912

NOTE: FULL LINES REPRESENT TORQUE FOR SPECTACLE MOVEMENTS 0° TO 90° [STOP TO PROCEED]
DOTTED LINES REPRESENT TORQUE FOR SPECTACLE MOVEMENTS 90° TO 0° [PROCEED TO STOP]



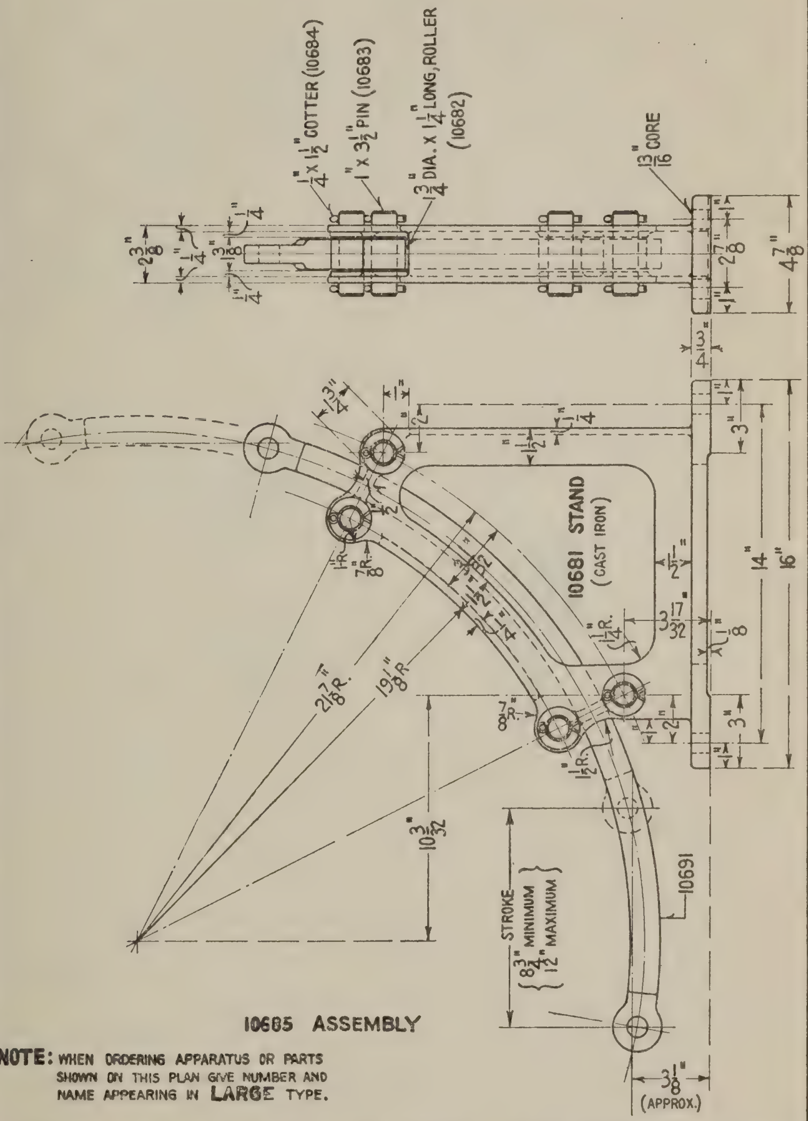


NOTE: SPECTACLE EQUIPPED WITH $8\frac{3}{8}$" ROUNDELS AND RETAINING RINGS IN ALL CASES.

TORQUE CURVES FOR ELECTRIC SEMAPHORE SPECTACLES

RSA
1064

DEC. 1912 OCT. 1912.


1/4" x 1 1/2" COTTER (10684)
1" x 3 1/2" PIN (10683)
1 3/4" DIA. x 1 1/4" LONG, ROLLER (10682)
13/16" CORE
2 3/8"
1/4"
1 3/8"
1/4"
1/4"
1/4"
2 7/8"
4 7/8"
1"
1"
3/4"
1 3/4"
1/2"
1/2"
1 1/4"
1 1/2"
1"
3"
14"
16"
10681 STAND (CAST IRON)
2 1/2"
3 17/32
1 1/8"
1 1/4" R.
3"
2"
1"
1"
1" R.
7/8" R.
3 1/2"
1 1/2"
1 1/4"
21 7/8" R.
19 1/8" R.
7/8" R.
1 1/2" R.
10 3/32"
STROKE {8 3/4" MINIMUM, 12" MAXIMUM}
10691
10685 ASSEMBLY
3 1/8"
(APPROX.)

NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE.

DETAILS AND ASSEMBLY OF VERTICAL DEFLECTING STAND

**RSA
1068**

OCT. 1912

IBRARY
THE
UNIVERSITY OF ILLIN

Engine with
Fuel and
Water Tanks.
Gasoline.
Specifications.

Galvanizing
for
Iron or Steel.
Specifications.

Generator.
Electric.
Specifications.

*SPECIFICATIONS FOR GALVANIZING FOR IRON OR STEEL.

1912.

1. *Purpose.*

These specifications give in detail the tests to be applied to galvanized material. All specimens shall be capable of withstanding these tests.

2. *Coating.*

The galvanizing shall consist of a continuous coating of pure zinc of uniform thickness, and so applied that it adheres firmly to the surface of the iron or steel. The finished product shall be smooth.

3. *Cleaning.*

(a) The samples shall be cleaned before testing, first with carbona, benzine or turpentine and cotton waste (not with a brush), and then thoroughly rinsed in clean water and wiped dry with clean cotton waste.

(b) The sample shall be clean and dry before each immersion in the solution.

4. *Solution.*

(a) The standard solution of copper sulphate shall consist of commercial copper sulphate crystals dissolved in cold water, about in the proportion of thirty-six (36) parts, by weight, of crystals to one hundred (100) parts, by weight, of water. The solution shall be neutralized by the addition of an excess of chemically pure cupric oxide (CuO). The presence of an excess of cupric oxide will be shown by the sediment of this reagent at the bottom of the containing vessel.

(b) The neutralized solution shall be filtered before using by passing through filter paper. The filtered solution shall have a specific gravity of 1.186 at sixty-five (65) degrees Fahr. (reading the scale at the level of the solution) at the beginning of each test. In case the filtered solution is high in specific gravity, clean water shall be added to reduce the specific gravity at 1.186 at sixty-five (65) degrees Fahr. In case the filtered solution is low in specific gravity, filtered solution of a higher specific gravity shall be added to make the specific gravity 1.186 at sixty-five (65) degrees Fahr.

---

*Adopted by the American Railway Engineering Association and the American Railway Association in 1912.

4. *Solution.*—Continued.

(c) As soon as the stronger solution is taken from the vessel containing the unfiltered neutralized stock solution, additional crystals and water must be added to the stock solution. An excess of cupric oxide shall always be kept in the unfiltered stock solution.

5. *Quantity of solution.*

(a) Wire samples shall be tested in a glass jar of at least two (2) inches inside diameter. The jar without the wire samples shall be filled with standard solution to a depth of at least four (4) inches. Hardware samples shall be tested in a glass or earthenware jar containing at least one-half pint of standard solution for each hardware sample.

(b) Solution shall not be used for more than one series of four immersions.

6. *Samples.*

(a) Not more than seven wires shall be simultaneously immersed, and not more than one sample of galvanized material other than wire shall be immersed in the specified quantity of solution.

(b) The samples shall not be grouped or twisted together, but shall be well separated so as to permit the action of the solution to be uniform upon all immersed portions of the samples.

7. *Test.*

(a) Clean and dry samples shall be immersed in the required quantity of standard solution in accordance with the following cycle of immersions.

(b) The temperature of the solution shall be maintained between sixty-two (62) degrees and sixty-eight (68) degrees Fahr. at all times during the following test:

(1) Immerse for one minute, wash and wipe dry.
(2) Immerse for one minute, wash and wipe dry.
(3) Immerse for one minute, wash and wipe dry.
(4) Immerse for one minute, wash and wipe dry.

(c) After each immersion the samples shall be immediately washed in clean water having a temperature between sixty-two (62) and sixty-eight (68) degrees Fahr., and wiped dry with cotton waste.

(d) In the case of number 14 galvanized iron or steel wire, the time of the fourth immersion shall be reduced to one-half minute.

8. *Acceptance.*

(a) If after the test described in section 7, paragraph (a), there should be a bright metallic copper deposit upon the samples, the lot represented by the samples shall be rejected.

(b) Copper deposits on zinc or within one (1) inch of the cut end shall not be considered causes for rejection.

(c) In the case of a failure of only one wire in a group of seven wires immersed together, or if there is a reasonable doubt as to the copper deposit, two (2) check tests shall be made on these seven (7) wires and the lot reported in accordance with the majority of the sets of tests.

Note.—The equipment necessary for the tests herein outlined is as follows:

Filter paper.
Commercial copper sulphate crystals.
Chemically pure cupric oxide (Cu O).
Running water.
Warm water or ice, as per needs.
Carbona, benzine or turpentine.
Glass jars at least two (2) inches inside diameter by at least four and one-half (4 1/2) inches high.
Glass or earthenware jars for hardware samples.
Vessels for washing samples.
Tray for holding jars of stock solution.
Jars, bottles and porcelain basket for stock solution.
Cotton waste.
Hydrometer cylinder three (3) inches in diameter by fifteen (15) inches high.
Thermometer with large Fahrenheit scale correct at sixty-two (62) degrees and sixty-eight (68) degrees.
Hydrometer correct at 1.186 at sixty-five (65) degrees.

Impedance
Bonds.
Specifications.

Impregnation.
Coils and
Windings.
Specifications.

Interlocking.

ELECTRIC—Specifications.
ELECTRO-PNEUMATIC—Specifications.
MECHANICAL—Specifications.

Iron.

CASTINGS, GRAY—Specifications.
MALLEABLE—Specifications.
WROUGHT BARS—Specifications.

SPECIFICATIONS FOR CORE TYPE IMPEDANCE BONDS.—DIRECT CURRENT PROPULSION.

1912.

1. *Purpose.*

These specifications are intended to provide impedance bonds of the core type for signaling on railroads using direct current propulsion.

2. *Design.*

(a) The general design and dimensions of the bonds shall be according to .... drawing ....

(b) The case and cover shall be of cast iron, weather and dust proof. Fastening so designed that they can be supported between track ties or on foundation according to .... drawing .... Case and cover shall be so arranged that bond can be easily inspected or removed.

(c) Arrangement of terminals shall be such that leads connecting on to the rails or adjacent bonds will be in minimum lengths.

3. *Materials and workmanship.*

Materials and workmanship shall be first class in every respect.

4. *Connecting leads.*

Connecting leads shall be in accordance with .... drawing ....

5. *Capacity.*

They shall carry .... (..) amperes of propulsion current per rail continuously and .... (..) amperes of propulsion current per rail for two hours without injurious heating, and allow of an unbalancing of .... (..) per cent. of total capacity per track without causing a change in impedance of more than .... (..) per cent. and shall not consume more than .... (..) amperes at .... (..) volts of signal current at .... (..) cycles.

6. *Ohmic resistance.*

The resistance of each bond shall not exceed .... (..) ohms.

7. *Inspection and tests.*

(a) The Manufacturer shall provide at his factory apparatus and other facilities needed for making the required physical and electrical tests. He shall give free access to the place of manufacture and opportunity for inspecting and testing the product at all stages of manu-

7. *Inspection and tests.*—Continued.

facture. At least three (3) days notice of material ready for test must be given.

(b) They shall withstand a breakdown test of one thousand (1000) volts alternating current of .... frequency from coil to coil and of two thousand (2000) volts alternating current between either coil and the case.

8. *Acceptance.*

If, after physical inspection of material and assembled bonds furnished, and in accordance with the tests herein enumerated, these specifications are met, bonds will be accepted; if these specifications are not met bonds will be rejected.

SPECIFICATIONS FOR ELECTRIC INTERLOCKING

To be installed at..............................
on the...................... R...............

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65. *Generator.*

The electric generator shall comply with the specifications of the Railway Signal Association covering "Electric generator."

70. *Motor.*

The motor shall be .... (..) horsepower, with a rated speed not to exceed .... (..) r. p. m., if direct current, or one thousand, eight hundred (1800) r. p. m., if alternating current, and shall have automatic regulation to within twenty (20) per cent., when operating on .... (..) to .... (..) volts d. c., or on .... (..) to .... (..) volts .... (..) cycles .... phase a. c., shall comply with Railway Signal Association specifications for "Electric generators" regarding heating, sparking and insulation, and shall be furnished with a starting panel.

75. *Motor generator.*

Motor generator shall be direct connected, mounted on a cast iron sub-base and shall conform to the specifications for motors and generators (Sections 65 and 70).

80. *Transformers.*

Transformers shall comply with {Railway Signal Association Specifications / ....} for "Transformers." 1912.

85. *Storage battery.*

(a) The battery shall consist of .... (..) cells, of .... (..) ampere hour capacity, manufactured by .... or ....

(b) The battery and installation shall comply with the directions of the Railway Signal Association covering the "Installation of lead type stationary storage batteries."

(c) .... (..) hydrometers and .... (..) extra jars shall be provided by the ....

(d) Battery room shall conform to the Purchaser's drawing ....

(e) The battery rack shall be supplied in place by the .... and shall conform to .... drawings ....

(f) The initial charge shall be conducted by the .... and shall be in accordance with the Manufacturer's instructions.

(g) The .... shall provide current at the proper voltage for the initial charge.

90. *Switchboards.*

Switchboards with fittings shall comply with the specifications of the Railway Signal Association, for "Switchboards."

INTERLOCKING MACHINE.

100. *Machine.*

(a) Interlocking machine shall have:

.... (..) levers for switches and derails.
.... (..) movable point frogs.
.... (..) crossing bars.
.... (..) levers for signals.
.... (..) levers for special purposes.
.... (..) total working levers.
.... (..) spare levers.
.... (..) spare spaces.
.... (..) lever frame.

(b) Like parts of machine of same type shall be interchangeable and all bolts shall be provided with jam nuts or nut locks.

101. *Locking*

(a) Machine shall be provided with mechanical locking of the preliminary type.

(b) For each lever and each spare space, depending upon the type of machine, provision shall be made in the locking bed for space to accommodate either one (1) locking shaft, with one (1) cross locking bar and with one (1) longitudinal locking bar for the full length of the machine, or one (1) tappet with one (1) longitudinal locking bar the full length of the machine. The locking parts above referred to shall not be furnished in spare spaces provided, unless called for by the Purchaser.

(c) Locking shall be distributed as uniformly as possible in the locking bed and so arranged as to be easily accessible.

102. *Levers.*

(a) Levers shall be numbered from left to right hand and to correspond with drawing ...., dated ....

(b) Levers shall be arranged so that they can be removed without interfering with other levers.

(c) Spare levers, as specified under Section 100, shall be furnished in place complete, ready for the operation and control of their respective units.

343. *Stops and guides.*—Continued.

feet of bar (equally spaced) and not less than two (2) such stops on one (1) bar.

344. *Driving pieces.*

Material.

(a) Driving pieces shall be wrought iron or steel, arranged for one and eleven-thirty-seconds (1 11/32) inch jaw connections. The part where the jaw is connected shall be three-fourths by two by three (3/4x2x3) inches, and part riveted to bar shall be one-half by two by six (1/2x2x6) inches, drilled for three (3) one-half (1/2) inch rivets, one (1) inch from end and two (2) inches between centers of holes. Offset from bar to jaw connection shall be one and one-half (1 1/2) inches.

Field work.

(b) Driving pieces shall be placed midway between two (2) clips in space not occupied by joint in bar, and the driving rod shall have a length of not more than seven (7) feet unsupported.

345. *Rocking shafts and fittings.*

Material.

(a) Rocking shafts shall be made of two (2) inch square rolled steel with movable bearings and movable crank arms. Arms shall be wrought iron nine (9) inches center to center.

(b) Rocking shaft bearings shall be made of cast iron and fastened to a one by three by twenty-four (1x3x24) inches wrought iron or steel bearer drilled at each end for two (2) three-fourths (3/4) inch bolts; the center of first hole shall be two (2) inches from ends and holes shall be spaced three (3) inches between centers.

Field work.

(c) Rocking shaft bearers shall be securely bolted to ties with four (4) three-fourths (3/4) inch bolts. The maximum spacing of bearers shall be six (6) feet centers.

348. *Section locking circuits.*

Section locking circuits will .... be required in $\left\{\begin{matrix}\text{addition to}\\\text{lieu of}\end{matrix}\right\}$ detector bars.

SIGNALS.

400. *Type and assembly.*

(a) Signals shall be of the semaphore type with arm travel .... (..) degrees in the .... $\left\{\begin{matrix}\text{right*}\\\text{left**}\end{matrix}\right\}$ quadrant.

---

*Adopted by the Railway Signal Association.

**Recommended for Interurban lines.

400. *Type and assembly.*—Continued.

(b) The type of signals (as shown by the Railway Signal Association symbols) and location of signals shall be in accordance with .... drawing ....

(c) Signals and fittings shall conform to Railway Signal Association material specifications.

(d) The spacing of arms on all masts shall be in accordance with Railway Signal Association drawings 1035 or 1037.

(e) Signals shall be mechanically locked in the horizontal position of the arm except as otherwise specified.

(f) Motors shall be of sufficient capacity and mechanism constructed to perform complete operation of a ninety (90) degree, three (3) position signal when not more than .... (..) feet from interlocking machine, in not more than .... (..) seconds with battery at ten (10) per cent. below normal voltage. The normal voltage of battery is one hundred and ten (110) volts. Fair working conditions consist of a distance of thirty-five hundred (3500) feet from interlocking machine and seven (7) seconds time of complete operation.

401. *Ground signals.*

The general design, dimensions and structure shall be in accordance with Railway Signal Association drawing 1035.

402. *Bracket signals*

(a) Bracket signal posts of pipe shall be made of .... (..) inch and .... (..) inch wrought iron pipe with water-tight joints, mounted in Railway Signal Association base drawing 1036. 1912.

(b) Top of crosstrees shall be .... (..) feet .... (..) inches above base of bracket post.

(c) Bracket signal posts of channel column construction shall be in accordance with Railway Signal Association drawing 1032. 1912.

403. *Bracket and bridge signals.*

Bracket and bridge signal masts shall be made of five (5) inch wrought iron pipe, mounted in Railway Signal Association base drawing 1034.

405. *Dwarf signals.*

(a) Dwarf signals shall be of $\left\{\begin{array}{l}\text{cast}\\ \text{wrought}\end{array}\right\}$ iron and shall be not more than .... (..) feet .... (..) inches from base to center of the bearing.

405. *Dwarf signals.*—Continued.

(b) Base castings for dwarf signals shall be cored for .... (..) bolts .... (..) inches in diameter at a radius of .... (..) inches.

(c) Use light, easily breakable, lead nuts to fasten dwarf signal base to foundation bolts.

410. *Semaphore spectacles.*

(a) High signal spectacles shall be in accordance with Railway Signal Association drawing $\left\{ \begin{matrix} 1040 \\ 1041 \end{matrix} \right\}$ with spectacle rings Railway Signal Association drawing 1042.

(b) Back lights $\left\{ \begin{matrix} \text{shall} \\ \text{shall not} \end{matrix} \right\}$ be furnished.

(c) Back light spectacle shall be designed for one (1) .... glass.

(d) Dwarf signal spectacles shall be $\left\{ \begin{matrix} \text{two} & (2) \\ \text{three} & (3) \end{matrix} \right\}$ light in accordance with Railway Signal Association drawing 1233.

1912.

415. *Signal blades.*

(a) High signal blades shall be in accordance with .... drawing ...., and shall be made of well seasoned white ash or ....

(b) Dwarf signal blades shall be flexible or hinged with dimensions in accordance with .... drawing ....

420. *Signal arm shafts.*

(a) High signal semaphore shafts shall be made of steel, not less than one and one-fourth (1 1/4) inches in diameter.

(b) Semaphore castings shall be mounted on square section of shaft. Operating arm shall be mounted on square section or otherwise securely fastened.

(c) Dwarf signal semaphore shafts shall be made of cold rolled steel .... (..) inches square.

425. *Roundels.*

Roundels shall comply with Railway Signal Association specifications and shall be supplied as follows:

	Color.	Dia. inches.
Caution	....	(..)
Stop, for high signal.....	....	(..)
Stop, for dwarf signal....	....	(..)
Proceed, for high signal..	....	(..)
Proceed, for dwarf signal	....	(..)
Back light	....	(..)

430. *Lamps.*

(a) Lamps shall be $\left\{\begin{array}{c}\text{oil}\\ \text{convertible}\end{array}\right\}$

(b) Oil lamps shall be in accordance with Railway Signal Association drawing 1100.

(c) Convertible lamps shall be equipped with .... (..) incandescent lamps and marine receptacles, in accordance with .... drawing ...., and with oil fonts and burners.

(d) .... (..) extra incandescent lamps shall be furnished.

431. *Lamp boxes.*

Lamp boxes shall be in accordance with .... drawing .... 1912.

435. *Signal locations.*

(a) Signal masts shall be on the right of the track governed and adjacent thereto where practicable.

(b) Signal arms on tangent shall be at right angles to track governed when sufficient approach is on tangent. On curves signal arms shall be at right angles to imaginary line drawn from the signal to the point where the best view can be obtained by the engineman, as decided by the Purchaser.

(c) Signals placed between tracks on tangent shall be set so that the center of mast shall be midway between tracks. Signals placed between tracks on curves shall be set off the center line between tracks and towards the center of the curve two and one-half (2 1/2) inches for each one (1) inch superelevation.

(d) Before any signals are erected, the Purchaser shall, in the presence of the Contractor's foreman (or other representative), locate each signal.

(e) Outside of tracks, dwarf signals shall be placed .... (..) feet, ground masts .... (..) feet and bracket posts .... (..) feet from nearest rail.

(f) Bridge masts shall be located on .... chord of bridge.

(g) Base of dwarf masts shall be .... (..) inches below base of rail. Base of high signals shall be .... (..) inches below base of rail.

CIRCUITS.

500. *Practice.*

Circuits shall comply with the Contractor's recommended practice unless otherwise specified.

501. *Switchboard circuits*

Contractor's recommended arrangement of circuits shall be followed, subject to necessary modifications on account of special requirements.

502. *Track circuits.*

(a) Contractor shall provide .... track circuits as shown by the shaded tracks on Purchaser's drawing ...., dated .... The purpose of each track circuit will be indicated on the plan by one or more of the following letters:

A.—For control of annunciators.
B.—For control of automatic block signals.
C.—For control of highway crossing alarms.
D.—In place of or in addition to detector bars.
F.—For control of fouling point indicators.
R.—For control of route locks.
S.—For control of semiautomatic signals.

(b) Main track circuits shall be extended to the fouling point or derail on siding switches; on crossovers track circuits shall be extended so as to provide as much fouling protection as can be obtained.

503. *Switch circuits.*

(a) Non-interlocked single main line switches, both ends of crossover switches and siding derails between home and distant signals shall be protected by switch circuit controllers.

(b) Circuits for facing point derails shall be controlled by normally closed circuit breakers on all signals governing over them.

504. *Signal circuits.*

(a) High and intermediate speed signals shall be so controlled that unless all facing point derails, switch and movable frog points over which they govern are in proper position and locked, the signals will assume the stop position. Low speed signals shall be controlled by facing point derails in the same manner.

(b) Each distant signal shall be controlled by circuit controllers on all non-interlocked single main line switches, both ends of crossover switches and siding derails, between home and distant signals and on all signals the indications of which it repeats, and so arranged that the circuit is broken unless all signals for the track governed are in proceed position.

505. *Cross protection circuits.*

Protective circuits shall be so arranged as to:

1. Automatically disconnect any unit or units improperly supplied with power.

2. Prevent the restoration of power until the trouble is removed.

3. Cause an operative failure in event of any failure in the protective circuit.

....

....

506. *Electric lighting circuits.*

(a) Electric lights on signals shall be arranged on ... . (..) circuits as follows:

....

....

(b) The maximum allowable drop in potential on electric lighting circuits from switchboard to any lamp shall be ten (10) per cent.

510. *Special circuits.*

The Purchaser will here indicate in full detail all special circuit requirements.

....

....

WIRE AND WIRING.

520. *Specification.*

Wire and cable shall comply with the specifications of the Railway Signal Association.

521. *Size.*

(a) Wires shall be of sufficient size to permit operation of switch and signal mechanism in accordance with previous specifications.

(b) Rubber covered wire smaller than number fourteen (14) B. & S. gauge shall not be used.

(c) Hard-drawn copper line wire shall not be smaller than number ten (10) B. & S. gauge.

(d) No common return wire shall be less than number twelve (12) B. & S. gauge.

(e) In submarine cable work spare wires up to twenty-five (25) per cent. of the number in use shall be provided as specified. When spare wires are required in other than cable work the number and size shall be specified.

(f) Numbers and sizes of track circuit connections shall be as follows:

530. *Tags.*—Continued.

Field work.

(c) Wires shall be tagged at all junction boxes, switches, signals, relay boxes, arrester boxes, and at all line wire connections, unless otherwise specified.

532. *Petroleum asphaltum.*

Material.

(a) Petroleum asphaltum shall comply with specifications of the Railway Signal Association for "Petroleum Asphaltum."

Field work.

(b) When specified, the wires in the trunking shall be loosely bound and shall be so laid in pitch as to be practically free of contact with all walls of the trunking.

(c) When petroleum asphaltum is used, terminal box bootlegs, trunking and bootleg terminals shall be in accordance with Railway Signal Association drawings 1154, 1155, 1156 and 1157.

BONDING.

540. *Bonding wires.*

Material.

(a) Bonding wires shall comply with Railway Signal Association specification for "Bonding Wires."

Field work.

(b) Number six (6) B. &. S. gauge bare copper or copper-clad steel bonding wires shall be used in tunnels, highways and street crossings and in station platforms.

(c) Bonding shall be in accordance with .... drawing .... Rail joints, except as below, shall be bonded with two (2) E. B. B. bonding wires. Where joints are located in platforms or road crossings, whether of plank, brick, or ballast filling, four (4) wires must be used at each joint, two (2) being placed on either side of rail and outside of angle bar.

(d) Frogs shall be bonded in the same manner as the rail joints and shall be so connected, that the continuity of the track circuit will be broken when they are removed from the track.

542. *Channel pins.*

Material.

(a) Channel pins shall comply with the specifications of the Railway Signal Association for "Channel pins."

542. *Channel pins.*—Continued.

Field work.

(b) Each bond wire shall be fastened at each end into the web of the rail by a channel pin.

(c) Bonding shall be completed the same day that holes are drilled.

ISOLATED BATTERIES.

550. *Track batteries.*

Material.

(a) Track batteries shall be of the gravity, storage or .... type.

(b) Storage batteries shall be of .... (..) ampere hour capacity of the .... or .... manufacture. They should have not less than one hundred and twenty (120) ampere hour capacity.

(c) Where lead type portable storage batteries are used thy shall comply with Railway Signal Association specifications for "Lead type portable storage batteries."

Field work.

(d) When gravity battery is used, each track circuit shall be operated by at least two (2) cells connected in multiple.

551. *Gravity battery jars.*

Jars shall be of .... glass, six (6) inches in diameter by eight (8) inches in height (inside dimensions) by one-eighth (1/8) inch thick.

552. *Gravity battery zincs.*

Zincs shall comply with the specifications of the Railway Signal Association for "Battery zincs"—drawing 1087. 1912.

553. *Copper sulphate*

Copper sulphate shall comply with the specifications of the Railway Signal Association for "Copper sulphate."

554. *Gravity battery coppers.*

Coppers shall be $\left\{\begin{array}{l}\text{two leaf}\\ \text{three leaf}\end{array}\right\}$ and shall comply with the specifications of the Railway Signal Association for "Gravity battery coppers"—drawing 1088. 1912.

556. *Signal and line control isolated batteries.*

(a) Batteries for signal and line circuits shall be of the primary or storage type.

(b) Storage batteries shall be of .... (..) ampere hour capacity, of the .... or .... manufacture.

556. *Signal and line control isolated batteries.*—Continued.

(c) Where lead type storage batteries are used they shall comply with the specifications of the Railway Signal Association for "Lead type portable storage batteries."

(d) Primary battery shall be of the $\left\{\begin{array}{c}\text{gravity}\\ \text{caustic soda}\end{array}\right\}$ type of .... (..) capacity. 1912.

(e) When caustic soda type of battery is used it shall comply with specifications of Railway Signal Association for "Caustic soda primary cell."

(f) Jars for caustic soda type of battery shall be $\left\{\begin{array}{l}\text{barrel shape}\\ \text{straight sided}\end{array}\right\}$ of $\left\{\begin{array}{l}\text{porcelain}\\ \text{heat resisting glass}\end{array}\right\}$ in accordance with Railway Signal Association drawing 1053. 1912.

CONTROL APPARATUS.

600. *Relays.*

Relays shall comply with specifications of the Railway Signal Association for "Relays."

610. *Circuit controllers.*

Material.

(a) Circuit controllers of substantial construction and positive in action shall be provided for such switch mechanisms as specified and shall be so constructed that they can be maintained to make or break circuit when switch point shall be moved from the closed position three-sixteenths (3/16) of an inch.

(b) Operating rods of switch circuit controllers shall be not less than one (1) inch in diameter and adjustable, with a maximum distance of three (3) feet between supports.

(c) Circuit controllers for non-interlocked switches shall have two independent shunt connections to the track circuit of each track effected by the opening of switch.

Field work.

(d) The switch circuit controller shall be positively connected to one or both points; if but one point, the normally .... shall be selected.

(e) The switch circuit controller shall be insulated from the tie plate and from the track.

615. *Electric locks.*

....

....

....

618. *Releases.*

Releases shall comply with Railway Signal Association's Specifiactions for "Mechanical and Electric Releases." 1912.

619. *Time releases.*

....
....
....

622. *Time locks.*

....
....
....

625. *Indicators.*

....
....
....

630. *Annunciators.*

....
....
....

635. *Lightning arresters.*

Material.

(a) Lightning arresters of .... design shall be used at all aerial line connections.

Field work.

(b) Lightning arresters shall be grounded through two (2) number eight (8) B. & S. gauge copper wires, (insulated above ground,) wrapped around and soldered to a galvanized ground rod not less than one (1) inch in diameter, driven eight (8) feet into the ground.

(c) Where such ground connection is not satisfactory the desired protection for each point will be specified by the Purchaser and furnished in place by the ....

TRUNKING, CONDUITS AND SUPPORTS.

700. *Trunking.*

Material.

(a) Grooved trunking, built up trunking and all capping shall be .... lumber and comply with the Railway Signal Association specification for "Wood trunking."

(b) The dimensions for trunking shall comply with Railway Signal Association drawings 1176 or 1177.

710. *Junction boxes.*—Continued.

(6) inches in length for each ten (10) additional connections or fraction thereof made in the box.

Field work.

(c) Junction boxes shall be located as shown on .... drawing .... and at a height sufficient to allow terminals to be placed at least six (6) inches above top of trunking.

(d) Junction boxes shall be supported in the same manner as the trunking.

711. *Conduits.*

(a) Fibre conduits shall comply with Railway Signal Association Specifications for "Fibre Conduits." 1912.

(b) Vitrified clay conduits shall comply with Railway Signal Association Specifications for "Vitrified Clay Conduits." 1912.

714. *Line construction.*

Line construction shall comply with local laws. 1912.

715. *Line supports.*

(a) Line wire shall be supported by cross arms, pins and insulators.

(b) Aerial cable shall be supported by messenger wire. Messenger wire shall be supported by L clamps which will be furnished in place by ....

(c) Cable shall be supported on messenger wire by hooks and marlin loops or by ....

(d) Line wire supports shall be furnished in place by ....

718. *Cable boxes.*

(a) Cables shall terminate in cable boxes in accordance with .... drawing ....

(b) Cable boxes shall be furnished in place by ....

INSTRUMENT AND BATTERY SHELTERS.

720. *Relay boxes.*

Material.

(a) Relay boxes at signals and track circuit limits shall be in accordance with ....drawings ...., and shall be made of
{ wood.
wood lined,
cast iron.

Field work.

(b) Terminals for relay boxes at signal locations shall be arranged in accordance with .... drawings ....

(c) Terminals in boxes at track circuit limits shall be arranged in accordance with .... drawing ....

721. *Relay cases*

Relay cases for interlocking station shall be in accordance with .... drawing .... and shall be neatly finished and dustproof.

722. *Lightning arrester boxes.*

Boxes for housing lightning arresters shall be in accordance with .... drawing ....

725. *Battery chutes.*

(a) Battery chutes shall be of cast iron $\left\{\begin{array}{ll}\text{six} & (6)\\ \text{seven} & (7)\\ \text{eight} & (8)\\ \text{nine} & (9)\end{array}\right\}$ feet long and in accordance with Railway Signal Association drawing $\left\{\begin{array}{l}1228\\ 1229\end{array}\right\}$ 1912.

(b) Elevators for battery chutes shall be in accordance with Railway Signal Association drawing 1227. 1912.

728. *Battery wells.*

(a) Battery wells shall be in accordance with .... drawing ....

(b) Concrete battery wells shall be .... (..) feet in diameter, ... (..) feet high, inside dimensions, and shall be water-tight.

(c) Frost neck .... (..) feet in diameter, ... (..) feet in height shall be furnished for each well.

(d) Durable wood covers protected by number eighteen (18) galvanized iron shall be provided. The covers shall be in accordance with .... drawing .... The covers shall be fastened with properly arranged chain or iron strap and provision made for locking.

(e) Shelving shall be arranged in the well in accordance with .... drawing ....

INSULATIONS.

735. *Insulated rail joints.*

Material.

(a) Insulated rail joints shall be in accordance with .... drawing ....

735. *Insulated rail joints.*—Continued.

Field work.

(b) Both rails shall be insulated at fouling points, ends of track circuits and in switch leads.

(c) Rail joints shall be installed by the Purchaser at joints designated by the Contractor.

738. *Switch rod insulations.*

Material.

(a) Switch rod insulations shall be in accordance with .... drawing ....

Field work.

(b) Insulations for switch rods shall be installed by the Purchaser at points designated by the Contractor.

(c) Switches to be insulated are equipped with........ .... (..) switch rods, ... (..) inches by .... (..) inches cross section, as shown on .... drawing .... except as noted on .... drawing .... dated ....

742. *Pipe line insulation.*

Material.

(a) Pipe line insulation shall be in accordance with Railway Signal Association drawing 1094.

Field work.

(b) Pipe line insulations shall be installed by the ....

744. *Tie plate insulations.*

Material.

(a) Tie plate insulations shall be in accordance with.. .... drawing ....

Field work.

(b) Insulated tie plates shall be installed by the ....

748. *Insulating fibre.*

Insulating fibre shall comply with Railway Signal Association specifications for "Hard fibre."

PAINTING.

800. *Paint.*

Material.

(a) Purchaser will indicate here the kind of paint that shall be required:

800. *Paint.*—Continued.

....
....
....

Field work.

(b) Surfaces covered with rust, grease, dirt or other foreign substances, shall be thoroughly cleaned before paint or oil is applied.

(c) Paint shall not be applied to outside surfaces in freezing weather, nor to wet surfaces, nor until previous coating has thoroughly dried.

(d) Finishing coats shall not be applied until after the expiration of forty-eight (48) hours after the previous coating has been applied.

(e) Paints mixed on the ground shall be applied within three (3) hours after the pigment and oil are mixed.

(f) Priming coats shall be applied as soon as is consistent with the progress of the work.

(g) Second coat shall be applied in sufficient time for the third coat to be applied and dry when the installation is completed.

810. *Iron work*

(a) Iron work (except machine, tie plates and iron foundation piers) not galvanized shall be painted one (1) coat of red lead and raw linseed oil and two (2) finishing coats.

(b) The following specific finishing coats shall be used:

	Kind of paint.	Color.
Signal bridges and brackets	....	....
Signal masts	....	....
Dwarf signals	....	....
All connections	....	....

(c) Outside iron connections, switch and signal fittings, not machine finished, shall be dipped in raw linseed oil before shipment from works.

820. *Machine.*

Machine and lever handles shall be of Purchaser's standard color, as follows:

	Color.
Case	....
Home signal levers	....
Distant signal levers	....
Lock levers	....
Other working levers	....
Spare levers	....
Releases	....

830. *Wood work.*

Exposed wood work shall be given one (1) priming coat and finishing coats as follows:

	Kind of paint.	Color.	Number of coats.
Home signal blades	....	....	......(..)
Dwarf signal blades	....	....	......(..)
Distant signal blades	....	....	......(..)
Trunking, junction boxes, etc.	....	....	......(..)
Foundation tops and bottoms	....	....	......(..)

840. *Buildings.*

Interlocking station and other buildings, if constructed of wood, shall receive one (1) priming coat and two (2) finishing coats. The priming coat shall consist of .... and, when thoroughly dry, two (2) coats of .... in the following tints, shall be applied:
....
....
....

SPECIAL ITEMS.

900.

....
....
....

925. *Locks.*

Purchaser's standard locks shall be used where specified.

926. *Number plates and numbers.*

(a) Number plates.
....
....
.... 1912.

(b) Numbers.
....
....
.... 1912.

928. *Junction terminals.*

Junction terminals shall be in accordance with Railway Signal Association drawing 1056. 1912.

950. *Drawbridges.*

Interlocking for drawbridges shall comply with Railway Signal Association recommendations.

SPECIFICATIONS FOR ELECTRO-PNEUMATIC INTERLOCKING.

To be installed at....................................
on the .... R.................

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10. *Inspection of material.*

Materials at any time before installation shall be subject to the inspection of the Purchaser's accredited representative.

11. *Supervision.*

The installation shall be made under the supervision and to the satisfaction of the Purchaser's accredited representative, hereinafter referred to as the Engineer.

12. *Completion.*

When the installation is complete the apparatus and the surface of the ground which has been effected by the installation shall be left in a neat and clean condition.

13. *Inspection of installation.*

Contractor shall advise the Purchaser .... (..) days in advance of the time the installation will be completed and ready for final inspection. The Purchaser will make final inspection and test within .... (..) days after the completion of the work to insure that the work has been completed in conformity with the specifications.

14. *Placing in service.*

(a) After receipt of written authority from the Purchaser, the Contractor shall place the installation in service under the supervision of the Purchaser, and shall leave .... (..) competent men on duty for ... . (..) days thereafter.

(b) Purchaser will place the installation in service in the event that he does not authorize the Contractor to do so within .... (..) days after the completion of the work to the Purchaser's satisfaction.

(c) Signal indications shall be displayed or changed only as authorized by the Purchaser.

(d) After the installation has been placed in service, the indication displayed by a signal shall be changed only as authorized by the Purchaser.

15. *Acceptance.*

After the installation has been operating satisfactorily in regular service .... (..) days and before final payment will be made, the Purchaser will give the Contractor a written acceptance of the installation.

16. *Changes and additions.*

(a) Changes and additions, as provided for in the contract, shall be made in accordance with these specifications.

(b) Additional work within the scope of the contract shall be done on the basis of the unit prices as stated in the contract.

17. *Alternative proposals.*

The proposals must meet the requirements of the specifications; however, if a bidder wishes to vary from the specifications or drawings, an alternative proposal may be submitted. Full information must be furnished with the alternative proposal to show wherein the requirements of these specifications are not met.

18. *Transportation.*

Purchaser will .... furnish free transportation for men, tools and material necessary for the installation over the following lines ....
....

20. *General electric requirements.*

(a) Electric apparatus shall withstand an insulation test at the place of manufacture of two thousand (2000) volts a. c. for one (1) minute.

(b) Magnets and solenoids shall be plainly marked with their resistance and the size of wire with which they are wound.

(c) Windings shall be treated in accordance with Railway Signal Association specifications for "Impregnation treatment for coils and windings."

DETAIL PROVISIONS.

BUILDINGS.

50. *Building foundations.*

.... foundations for the buildings shall be furnished in place by the .... in accordance with specifications and drawings ...., dated ...
....

51. *Interlocking station.*

(a) A .... building .... (..) stories high and .... by .... inside dimensions, shall be erected by the .... in accordance with ......
...... specifications and drawings ...., dated
....

63. *Air compressor.*

A $\left\{\begin{matrix}\text{one}\\ \text{two}\end{matrix}\right\}$ stage air compressor of ....(..) indicated horsepower, capacity of .... (..) cubic feet of free air per minute at .... (..) feet elevation above sea level, and designed for air pressure of .... (....) pounds, manufactured by .... , installed by the ...., shall be furnished on a .... foundation, to be furnished in place by the ...., constructed in accordance with the standard specifications of the ...., and drawings of the Manufacturer.

65. *Generator.*

The electric generator shall comply with the specifications of the Railway Signal Association covering "Electric generator."

70. *Motor.*

The motor shall be .... (....) horsepower, with a rated speed not to exceed .... (....) r. p. m., if direct current, or one thousand, eight hundred (1800) r. p. m., if alternating current, and shall have automatic regulation to within twenty (20) per cent., when operating on .... (....) to .... (....) volts d. c., or on .... (....) to .... (....) volts .... (....) cycles .... phase a. c., shall comply with Railway Signal Association specifications for "Electric generators" regarding heating, sparking and insulation, and shall be furnished with a starting panel.

75. *Motor generator.*

Motor generators shall be direct connected, mounted on a cast iron sub-base and shall conform to the specifications for motors and generators (Sections 65 and 70).

80. *Transformers.*

Transformers shall comply with $\left\{\begin{matrix}\text{Railway Signal Association Specifications}\\ \text{....................................}\end{matrix}\right\}$ for "Transformers." 1912.

85. *Storage battery.*

(a) The battery shall consist of .... (..) cells, of .... (..) ampere hour capacity, manufactured by .... or ....

85. *Storage battery.*—Continued.

(b) The battery and installation shall comply with the directions of the Railway Signal Association covering the "Installation of lead type stationary storage batteries."

(c) .... (..) hydrometers and .... (..) extra jars shall be provided by the ....

(d) Battery room shall conform to the Purchaser's drawing ....

(e) The battery rack shall be supplied in place by the .... and shall conform to .... drawings ....

(f) The initial charge shall be conducted by the .... and shall be in accordance with the Manufacturer's instructions.

(g) The .... shall provide current at the proper voltage for the initial charge.

90. *Switchboards.*

Switchboards with fittings shall comply with the specifications of the Railway Signal Association, for "Switchboards."

95. *Condensers.*

(a) Condensers are of two (2) types, atmospheric and water cooled. The former is usually ample for plants using two hundred (200) cubic feet of free air per minute, at a pressure of ninety (90) pounds per square inch or less. The latter is to be preferred when high pressure or greater volume is used, while a combination of both may be justifiable where extreme pressure and unusual volumes prevail.

(b) As close to the compressor as practicable .... atmospheric after coolers having a circulating area of at least twice that of the discharge pipe of the compressor and a radiating surface of .... (..) square feet per cubic foot capacity of compressor, with .... (..) auxiliary tanks shall be furnished on a .... foundation, over a .... pit, for the auxiliary tanks, by the ...., constructed in accordance with .... specifications. Each auxiliary tank shall be equipped with a blow out pipe extending from the bottom of the tank.

(c) A water after cooler having a circulating area of at least that of the discharge pipe of compressor and a radiating surface of .... (..) square feet per cubic foot capacity of compressor shall be furnished on a

400. *Type and assembly.*—Continued.

tion standard in not more than four (4) seconds, with minimum air pressure of sixty (60) pounds per square inch.

401. *Ground signals.*

The general design, dimensions and structure shall be in accordance with Railway Signal Association drawing 1035.

402. *Bracket signals.*

(a) Bracket signal posts of pipe shall be made of .... (..) inch and .... (..) inch wrought iron pipe with water-tight joints, mounted in Railway Signal Association base drawing 1036. 1912.

(b) Top of crosstrees shall be .... (..) feet .... (..) inches above base of bracket post.

(c) Bracket signal posts of channel column construction shall be in accordance with Railway Signal Association drawing 1032. 1912.

403. *Bracket and bridge signals.*

Bracket and bridge signal masts shall be made of five (5) inch wrought iron pipe, mounted in Railway Signal Association base drawing 1034.

405. *Dwarf signals.*

(a) Dwarf signals shall be of {cast / wrought} iron and shall be not more than .... (..) feet .... (..) inches from base to center of the bearing.

(b) Base castings for dwarf signals shall be cored for .... (..) bolts .... (..) inches in diameter at a radius of .... (..) inches.

(c) Use light, easily breakable, lead nuts to fasten dwarf signal base to foundation bolts.

410. *Semaphore spectacles.*

(a) High signal spectacles shall be in accordance with Railway Signal Association drawing {1040 / 1041} with spectacle rings Railway Signal Association drawing 1042.

(b) Back lights {shall / shall not} be furnished.

(c) Back light spectacle shall be designed for one (1) .... glass.

(d) Dwarf signal spectacles shall be {two (2) / three (3)} light in accordance with Railway Signal Association drawing 1233. 1912.

415. *Signal blades.*

(a) High signal blades shall be in accordance with ....drawing ...., and shall be made of well seasoned white ash or ....

(b) Dwarf signal blades shall be flexible or hinged with dimensions in accordance with .... drawing ....

420. *Signal arm shafts.*

(a) High signal semaphore shafts shall be made of steel, not less than one and one-fourth (1 1/4) inches in diameter.

(b) Semaphore castings shall be mounted on square section of shaft. Operating arm shall be mounted on square section or otherwise securely fastened.

(c) Dwarf signal semaphore shafts shall be made of cold rolled steel .... (..) inches square.

425. *Roundels.*

Roundels shall comply with Railway Signal Association specifications and shall be supplied as follows:

	Color.	Dia. inches.
Caution	....	.... (..)
Stop, for high signal.....	....	.... (..)
Stop, for dwarf signal....	....	.... (..)
Proceed, for high signal..	....	.... (..)
Proceed, for dwarf signal	....	.... (..)
Back light	....	.... (..)

430. *Lamps.*

(a) Lamps shall be $\left\{\begin{array}{c}\text{oil}\\ \text{convertible}\end{array}\right\}$

(b) Oil lamps shall be in accordance with Railway Signal Association drawing 1100.

(c) Convertible lamps shall be equipped with................. (..) incandescent lamps and marine receptacles, in accordance with .... drawing ...., and with oil fonts and burners.

(d) .... (..) extra incandescent lamps shall be furnished.

431. *Lamp boxes.*

Lamp boxes shall be in accordance with .... drawing .... 1912.

435. *Signal locations.*

(a) Signal masts shall be on the right of the track governed and adjacent thereto where practicable.

(b) Signal arms on tangent shall be at right angles to track governed when sufficient approach is on tangent. On curves signal arms shall be at right angles to imagi-

435. *Signal locations.*—Continued.

nary line drawn from the signal to the point where the best view can be obtained by the engineman, as decided by the Purchaser.

(c) Signals placed between tracks on tangent shall be set so that the center of mast shall be midway between tracks. Signals placed between tracks on curves shall be set off the center line between tracks and towards the center of the curve two and one-half (2 1/2) inches for each one (1) inch superelevation.

(d) Before any signals are erected, the Purchaser shall, in the presence of the Contractor's foreman (or other representative), locate each signal.

(e) Outside of tracks, dwarf signals shall be placed .... (..) feet, ground masts .... (..) feet and bracket posts .... (..) feet from nearest rail.

(f) Bridge masts shall be located on .... chord of bridge.

(g) Base of dwarf masts shall be .... (..) inches below base of rail. Base of high signals shall be .... (..) inches below base of rail.

CIRCUITS.

500. *Practice.*

Circuits shall comply with the Contractor's recommended practice unless otherwise specified.

501. *Switchboard circuits.*

Contractor's recommended arrangement of circuits shall be followed, subject to necessary modifications on account of special requirements.

502. *Track circuits.*

(a) Contractor shall provide .... track circuits as shown by the shaded tracks on Purchaser's drawing ...., dated .... The purpose of each track circuit will be indicated on the plan by one or more of the following letters:

A.—For control of annunciators.
B.—For control of automatic block signals.
C.—For control of highway crossing alarms.
D.—In place of or in addition to detector bars.
F.—For control of fouling point indicators.
R.—For control of route locks.
S.—For control of semiautomatic signals.

502. *Track circuits.*—Continued.

(b) Main track circuits shall be extended to the fouling point or derail on siding switches; on crossovers track circuits shall be extended so as to provide as much fouling protection as can be obtained.

*503. *Switch circuits.*

(a) Circuits for single switch shall be in accordance with Railway Signal Association drawing 1158. 1912.

(b) Circuits for single switch with section locking circuit shall be in accordance with Railway Signal Association drawings 1147 or 1162. 1912.

(c) Circuits for switches shall be in accordance with Railway Signal Association drawing 1160. 1912.

504. *Signal circuits.*

(a) High and intermediate speed signals shall be so controlled that unless all facing point derails, switch and movable frog points over which they govern are in proper position and locked, the signals will assume the stop position. Low speed signals shall be controlled by facing point derails in the same manner.

(b) Each distant signal shall be controlled by circuit controllers on all signals, the indications of which it repeats, and so arranged that the circuit is broken unless all signals for the track governed are in proceed position.

(c) Non-interlocked main line single switches, both switches of crossovers and siding derails between home and distant signals shall be equipped with switch circuit controllers.

*(d) Circuits for signals shall be in accordance with Railway Signal Association drawings 1148, 1159, 1161 or 1163. 1912.

505. *Cross protection circuits.*

....
....
....

506. *Electric lighting circuits.*

(a) Electric lights on signals shall be arranged on ... . (..) circuits as follows:

....
....
....

---

*Drawings referred to in Section 503 (a) (b) and (c), also 504 (d), will be found at end, and are made a part of, these Specifications.

551. *Gravity battery jars.*

Jars shall be of .... glass, six (6) inches in diameter by eight (8) inches in height (inside dimensions) by one-eighth (1/8) inch thick.

552. *Gravity battery zincs.*

Zincs shall comply with the specifications of the Railway Signal Association for "Battery zincs," drawing 1087. 1912.

553. *Copper sulphate.*

Copper sulphate shall comply with the specifications of the Railway Signal Association for "Copper sulphate."

554. *Gravity battery coppers.*

Coppers shall be $\left\{\begin{matrix}\text{two leaf}\\ \text{three leaf}\end{matrix}\right\}$ and shall comply with the specifications of the Railway Signal Association for "Gravity battery coppers," drawing 1088. 1912.

556. *Signal and line control isolated batteries.*

(a) Batteries for signal and line circuits shall be of the primary or storage type.

(b) Storage batteries shall be of .... (..) ampere hour capacity, of the .... or ,.......... manufacture.

(c) Where lead type storage batteries are used they shall comply with the specifications of the Railway Signal Association for "Lead type portable storage batteries."

(d) Primary battery shall be of the $\left\{\begin{matrix}\text{gravity}\\ \textbf{caustic}\text{ soda}\end{matrix}\right\}$ type of .... (..) capacity. 1912.

(e) When caustic soda type of battery is used it shall comply with specifications of Railway Signal Association for "Caustic soda primary cell."

(f) Jars for caustic soda type of battery shall be $\left\{\begin{matrix}\text{barrel shape}\\ \text{straight sided}\end{matrix}\right\}$ of $\left\{\begin{matrix}\text{heat resisting glass}\\ \text{porcelain}\end{matrix}\right\}$ in accordance with Railway Signal Association drawing 1053. 1912.

CONTROL APPARATUS.

600. *Relays.*

Relays shall comply with specifications of the Railway Signal Association for "Relays."

610. *Circuit controllers.*

Material.

(a) Circuit controllers of substantial construction and positive in action shall be provided for such switch mechanisms as specified and shall be so constructed that they

610. *Circuit controllers.*—Continued.

can be maintained to make or break circuit when switch point shall be moved from the closed position three-sixteenths (3/16) of an inch.

(b) Operating rods of switch circuit controllers shall be not less than five-eighths (5/8) inch in diameter and adjustable, with a maximum distance of three (3) feet between supports.

(c) Circuit controllers for non-interlocked switches shall have two independent shunt connections to the track circuit of each track effected by the opening of switch.

Field work.

(d) The switch circuit controller shall be positively connected to one or both points; if but one point, the normally .... shall be selected.

(e) The switch circuit controller shall be insulated from the tie plate and from the track.

615. *Electric locks.*

....

....

....

618. *Releases.*

Releases shall comply with Railway Signal Association Specifications for "Mechanical and Electric Releases." 1912.

619. *Time releases.*

....

....

....

625. *Indicators.*

....

....

....

630. *Annunciators.*

....

....

....

635. *Lightning arresters.*

Material.

(a) Lightning arresters of .... design shall be used at all aerial line connections.

Field work.

(b) Lightning arresters shall be grounded through two (2) number eight (8) B. & S. gauge copper wires, (insulated above ground,) wrapped around and soldered to a galvanized ground rod not less than one (1) inch in diameter, driven eight (8) feet into the ground.

708. *Bootlegs.*—Continued.

shall be securely fastened to the trunking, not less than two (2) inches from base of rail, and shall not extend more than one (1) inch above base of rail.

710. *Junction boxes.*

Material.

(a) Junction boxes shall be made of .... and so designed that terminals will be kept dry. Each junction box shall be fitted with a cover, hasp and staple.

(b) Where ten (10) or less wires are used, junction boxes shall be sixteen (16) inches square by twenty (20) inches deep, inside dimensions, and shall be increased six (6) inches in length for each ten (10) additional connections or fraction thereof made in the box.

Field work.

(c) Junction boxes shall be located as shown on...... .... drawing .... and at a height sufficient to allow terminals to be placed at least six (6) inches above top of trunking.

(d) Junction boxes shall be supported in the same manner as the trunking.

711. *Conduits.*

(a) Fibre conduits shall comply with Railway Signal Association's Specifications for "Fibre Conduits."

(b) Vitrified clay conduits shall comply with Railway Signal Association's Specifications for "Vitrified Clay Conduits." 1912.

714. *Line construction.*

Line construction shall comply with local laws.

715. *Line supports.*

(a) Line wire shall be supported by cross arms, pins and insulators.

(b) Aerial cable shall be supported by messenger wire. Messenger wire shall be supported by L clamps which will be furnished in place by ....

(c) Cable shall be supported on messenger wire by hooks and marlin loops or by ....

(d) Line wire supports shall be furnished in place by ....

718. *Cable boxes.*

(a) Cables shall terminate in cable boxes in accordance with .... drawing ....

(b) Cable boxes shall be furnished in place by ....

INSTRUMENT AND BATTERY SHELTERS.

720. *Relay boxes.*

Material.

(a) Relay boxes at signals and track circuit limits shall be in accordance with .... drawings ...., and shall be made of {
wood.
wood lined,
cast iron.
}

Field work.

(b) Terminals for relay boxes at signal locations shall be arranged in accordance with ....drawings ....

(c) Terminals in boxes at track circuit limits shall be arranged in accordance with .... drawings ....

721. *Relay cases.*

Relay cases for interlocking station shall be in accordance with .... drawing .... and shall be neatly finished and dustproof.

722. *Lightning arrester boxes.*

Boxes for housing lightning arresters shall be in accordance with .... drawing ....

725. *Battery chutes.*

(a) Battery chutes shall be of cast iron {
six (6)
seven (7)
eight (8)
nine (9)
}
feet long and in accordance with Railway Signal Association drawing {
1228
1229
}. 1912.

(b) Elevators for battery chutes shall be in accordance with Railway Signal Association drawing 1227. 1912.

728. *Battery wells.*

(a) Battery wells shall be in accordance with .... drawing ....

(b) Concrete battery wells shall be .... (..) feet in diameter, ... (..) feet high, inside dimensions, and shall be water-tight.

(c) Frost neck .... (..) feet in diameter, ... (..) feet in height shall be furnished for each well.

810. *Iron work.*—Continued.

(c) Outside iron connections, switch and signal fittings, not machine finished, shall be dipped in raw linseed oil before shipment from works.

820. *Machine.*

Machine and lever handles shall be of Purchaser's standard color, as follows:

	Color.
Case	....
Home signal levers	....
Distant signal levers	....
Lock levers	....
Other working levers	....
Spare levers	....

830. *Wood work.*

Exposed wood work shall be given one (1) priming coat and finishing coats as follows:

	Kind of paint.	Color.	Number of coats.
Home signal blades	....	....	......(..)
Dwarf signal blades	....	....	......(..)
Distant signal blades	....	....	......(..)
Trunking, junction boxes, etc.	....	....	......(..)
Foundation tops and bottoms	....	....	......(..)

840. *Buildings.*

Interlocking station and other buildings, if constructed of wood shall receive one (1) priming coat and two (2) finishing coats. The priming coat shall consist of .... and, when thoroughly dry, two (2) coats of .... in the following tints, shall be applied:

....

....

....

SPECIAL ITEMS.

900.

....

....

....

925. *Locks.*

Purchaser's standard locks shall be used where specified.

926. *Number plates and numbers.*

(a) Number plates.

....

....

.... 1912.

(b) Numbers.

....

....

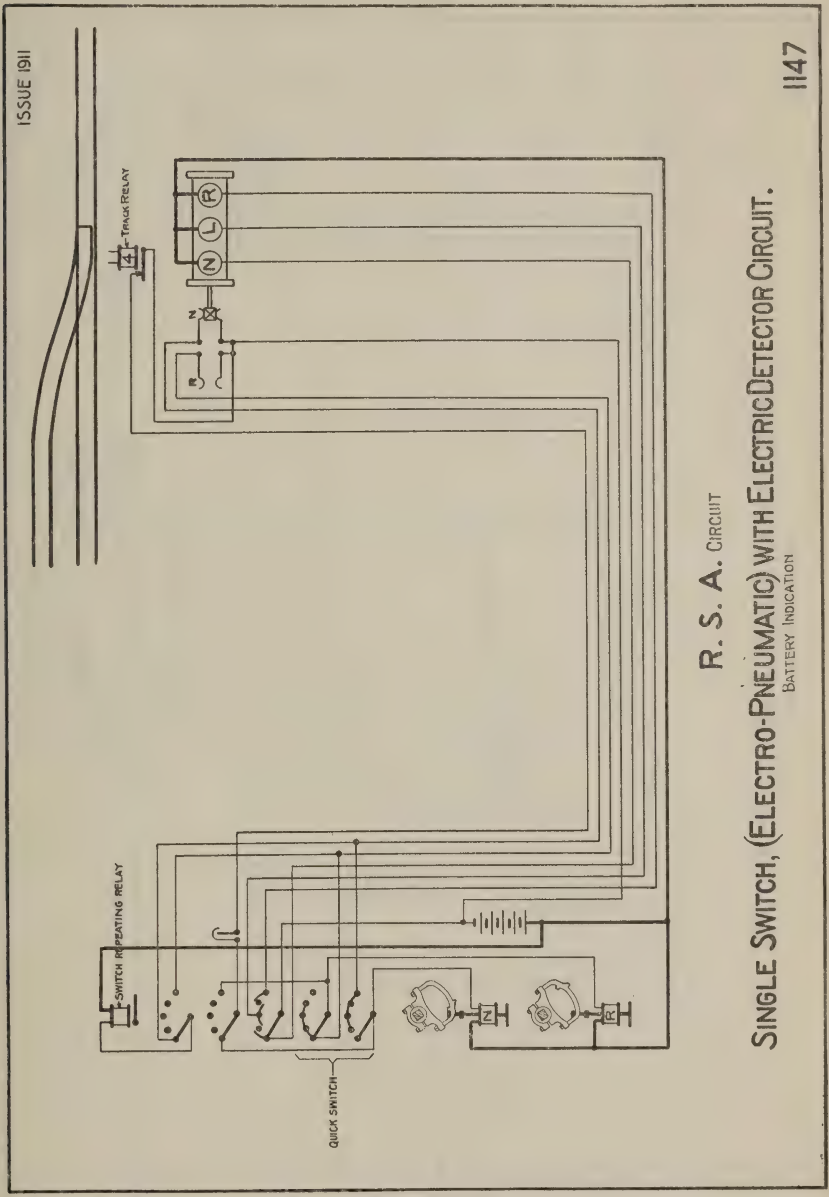
.... 1912.

928. *Junction terminals.*

Junction terminals shall be in accordance with Railway Signal Association drawing 1056. 1912.

950. *Drawbridges.*

Interlocking for drawbridges shall comply with Railway Signal Association recommendations.

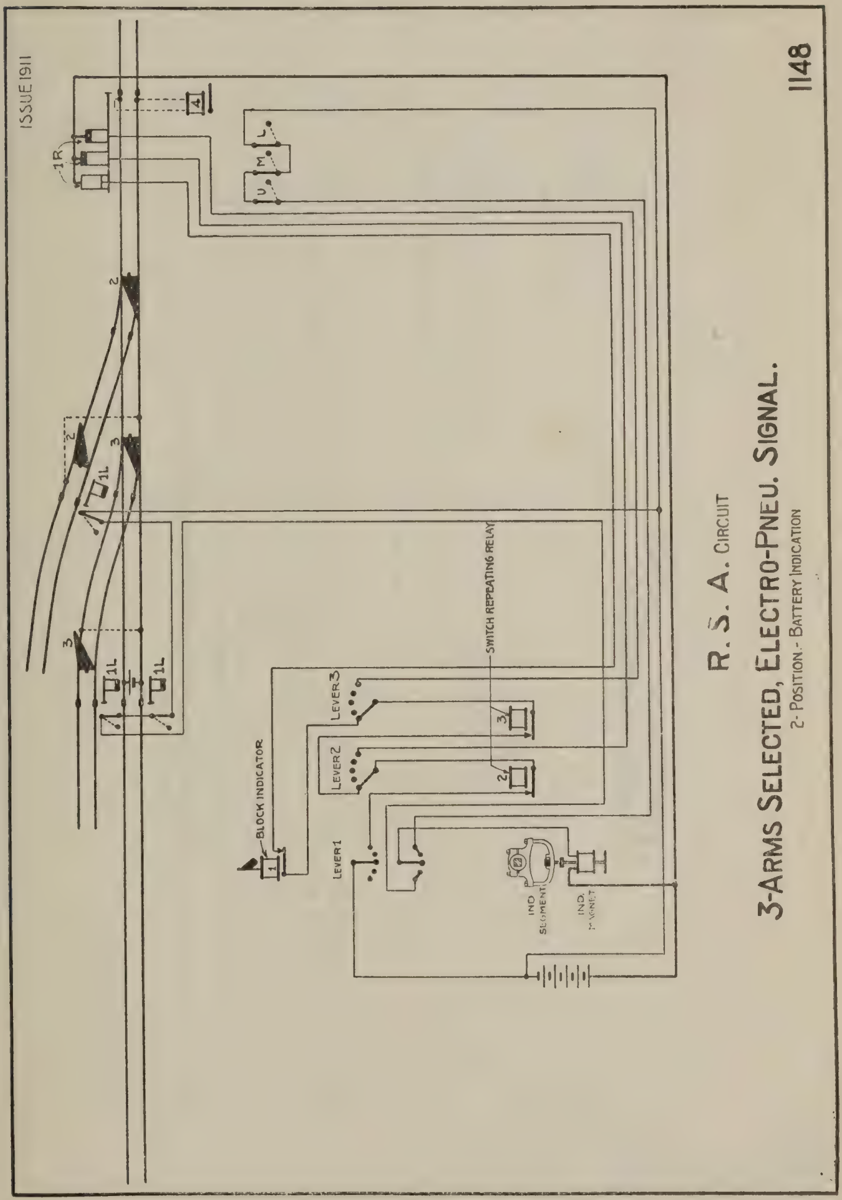

ISSUE 1911
1147
TRACK RELAY
4
R
L
N
N
R
SWITCH REPEATING RELAY
QUICK SWITCH
N
R

R. S. A. CIRCUIT

SINGLE SWITCH, (ELECTRO-PNEUMATIC) WITH ELECTRIC DETECTOR CIRCUIT.

BATTERY INDICATION

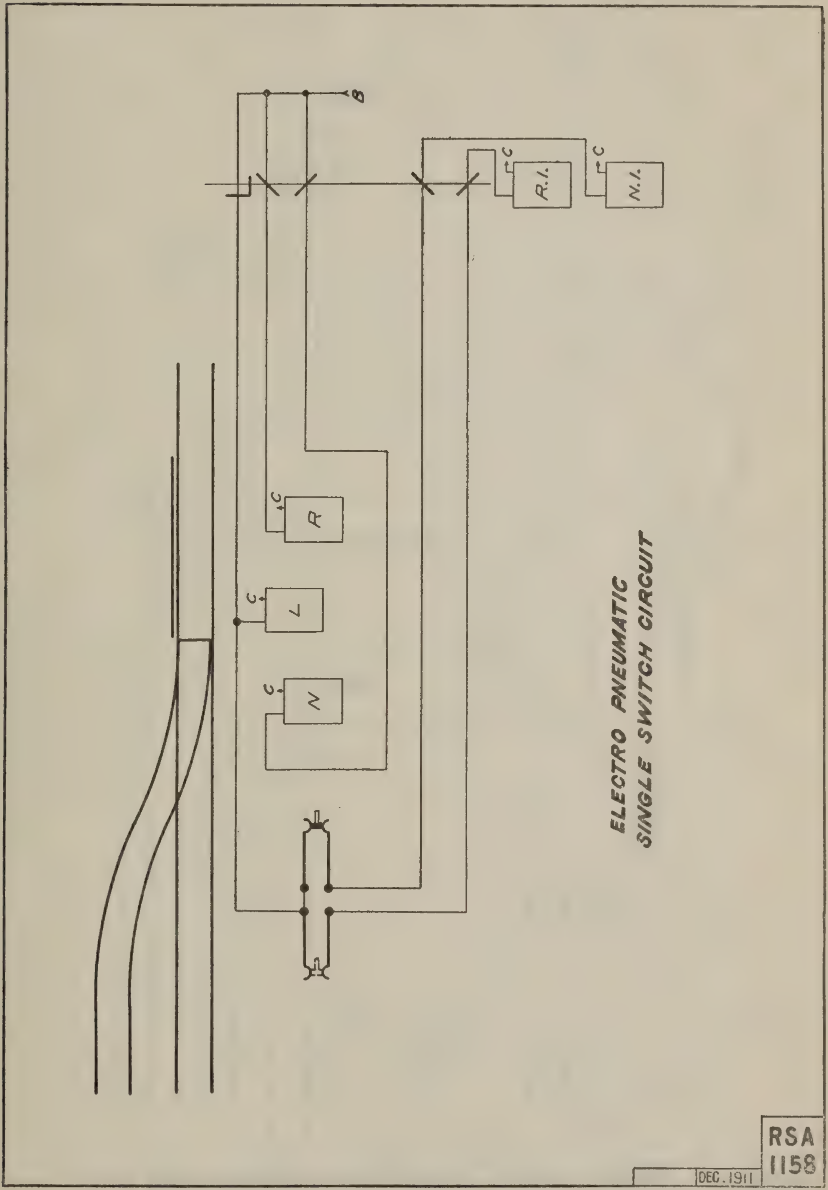
LIBRARY
OF THE
UNIVERSITY OF ILLINOIS


ISSUE 1911
1148
1R
U
M
L
4
2
3
1L
SWITCH REPEATING RELAY
LEVER 3
LEVER 2
LEVER 1
BLOCK INDICATOR
1
IND. SEGMENT
IND. MAGNET

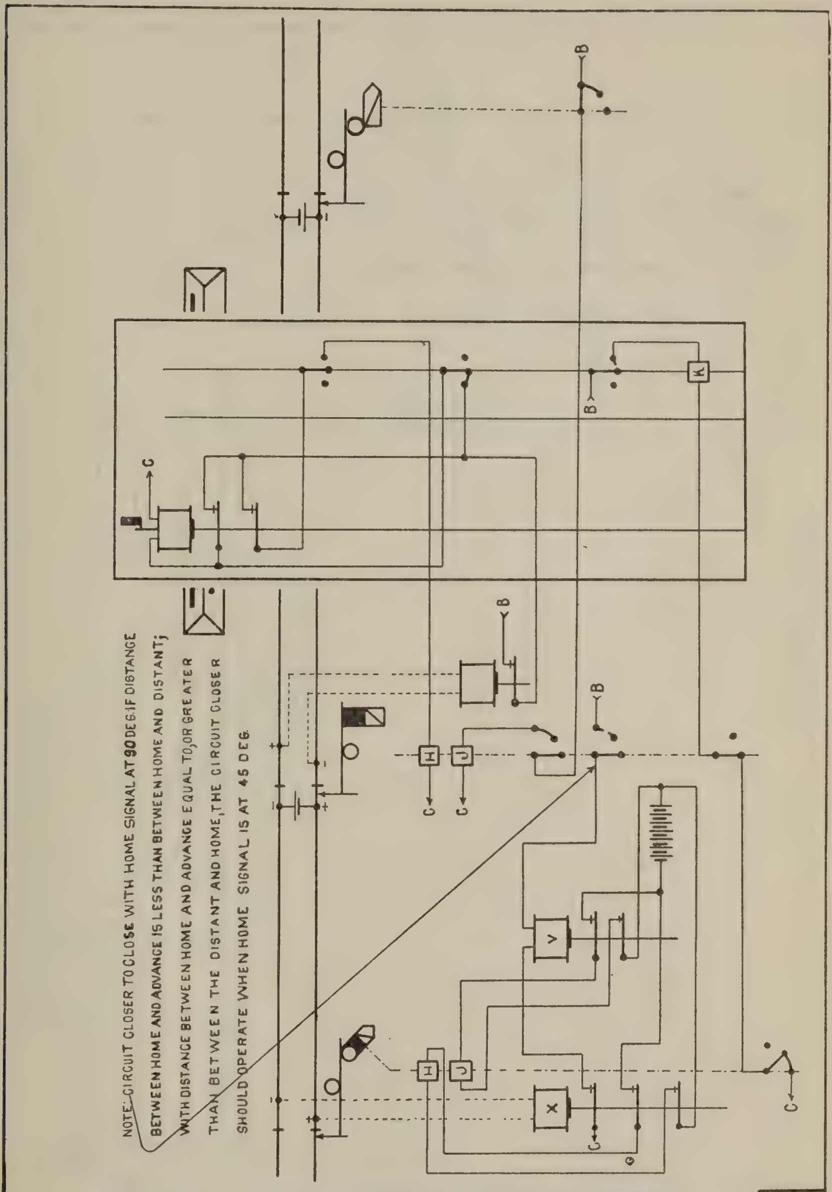
R. S. A. CIRCUIT

3-ARMS SELECTED, ELECTRO-PNEU. SIGNAL.

2-POSITION.- BATTERY INDICATION


B
C
R.I.
N.I.
R
L
N
ELECTRO PNEUMATIC
SINGLE SWITCH CIRCUIT
RSA
1158
DEC. 1911

One-arm signal within automatic block limits.

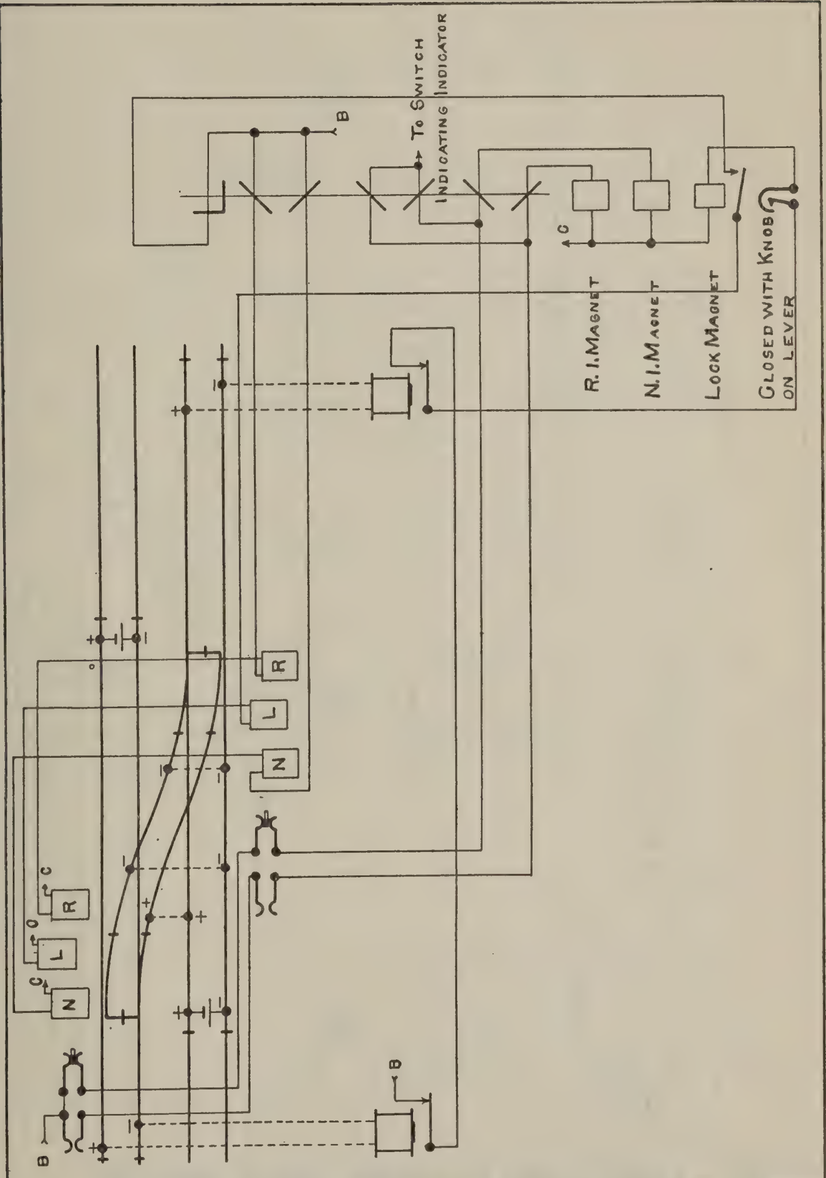

NOTE: CIRCUIT CLOSER TO CLOSE WITH HOME SIGNAL AT 90 DEG. IF DISTANCE BETWEEN HOME AND ADVANCE IS LESS THAN BETWEEN HOME AND DISTANT; WITH DISTANCE BETWEEN HOME AND ADVANCE EQUAL TO, OR GREATER THAN BETWEEN THE DISTANT AND HOME, THE CIRCUIT CLOSER SHOULD OPERATE WHEN HOME SIGNAL IS AT 45 DEG.
B
C
K
H
J
V
X
+
-

ONE ARM ELECTRO PNEUMATIC SIGNAL CIRCUIT.
(BLOCK STATION WITHIN AUTOMATIC LIMITS)

DEC. 1911

RSA
1159

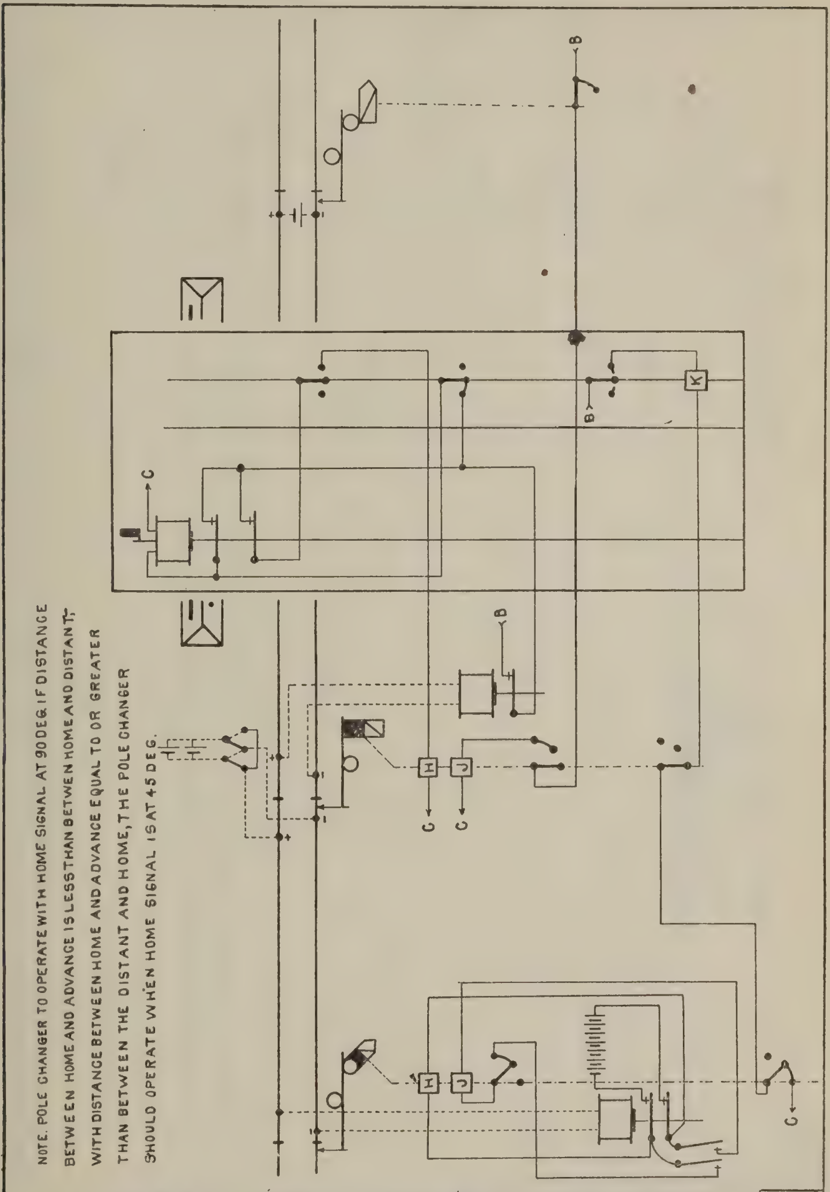
OF THE
UNIVERSITY OF ILLINOIS


To Switch Indicating Indicator
B
C
R. I. Magnet
N. I. Magnet
Lock Magnet
Closed with Knob on Lever
R
L
N
R
L
N
C
O
C
B
B

ELECTRO PNEUMATIC SECTION LOCKING FOR CROSSOVER SWITCH

RSA
1160

DEC. 1911



NOTE. POLE CHANGER TO OPERATE WITH HOME SIGNAL AT 90 DEG. IF DISTANCE BETWEEN HOME AND ADVANCE IS LESS THAN BETWEEN HOME AND DISTANT; WITH DISTANCE BETWEEN HOME AND ADVANCE EQUAL TO OR GREATER THAN BETWEEN THE DISTANT AND HOME, THE POLE CHANGER SHOULD OPERATE WHEN HOME SIGNAL IS AT 45 DEG.

ONE ARM ELECTRO PNEUMATIC SIGNAL CIRCUIT

(BLOCK STATION WITHIN AUTOMATIC LIMITS)

DEC. 1911

RSA 1161

LIBRARY
OF THE
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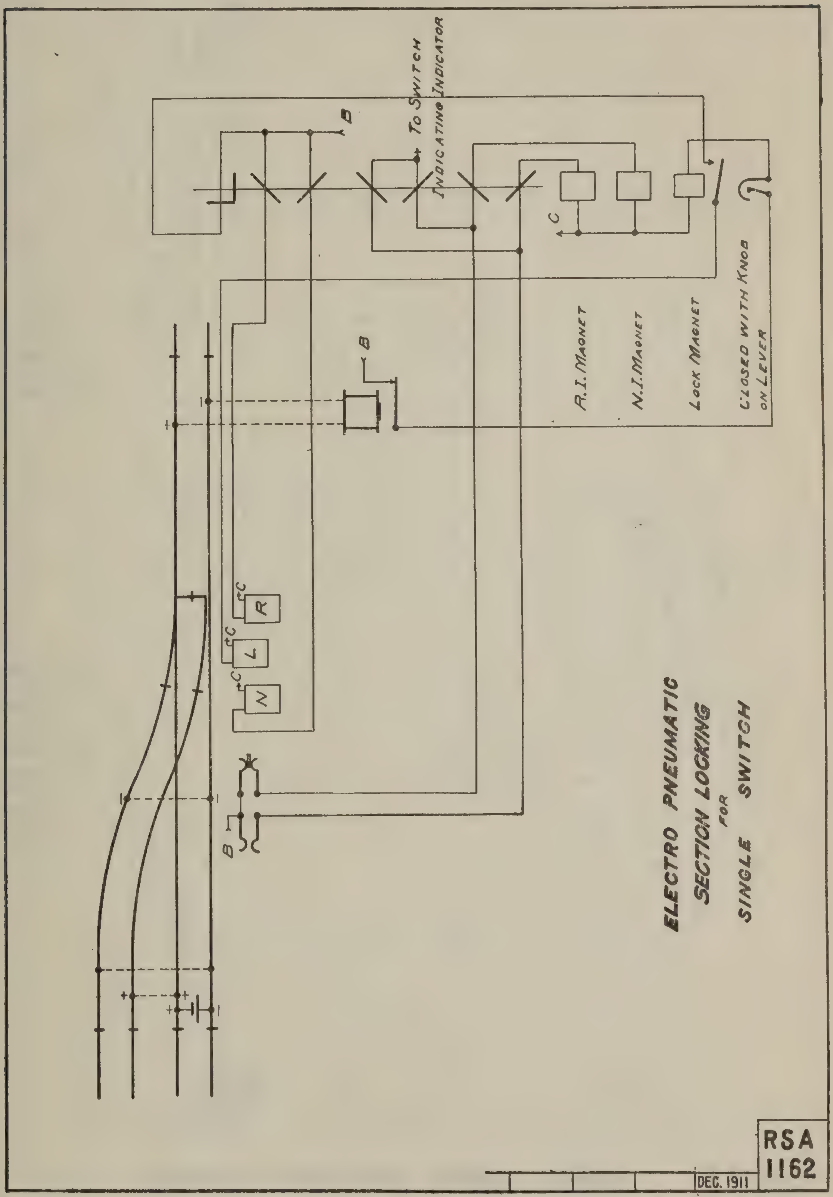
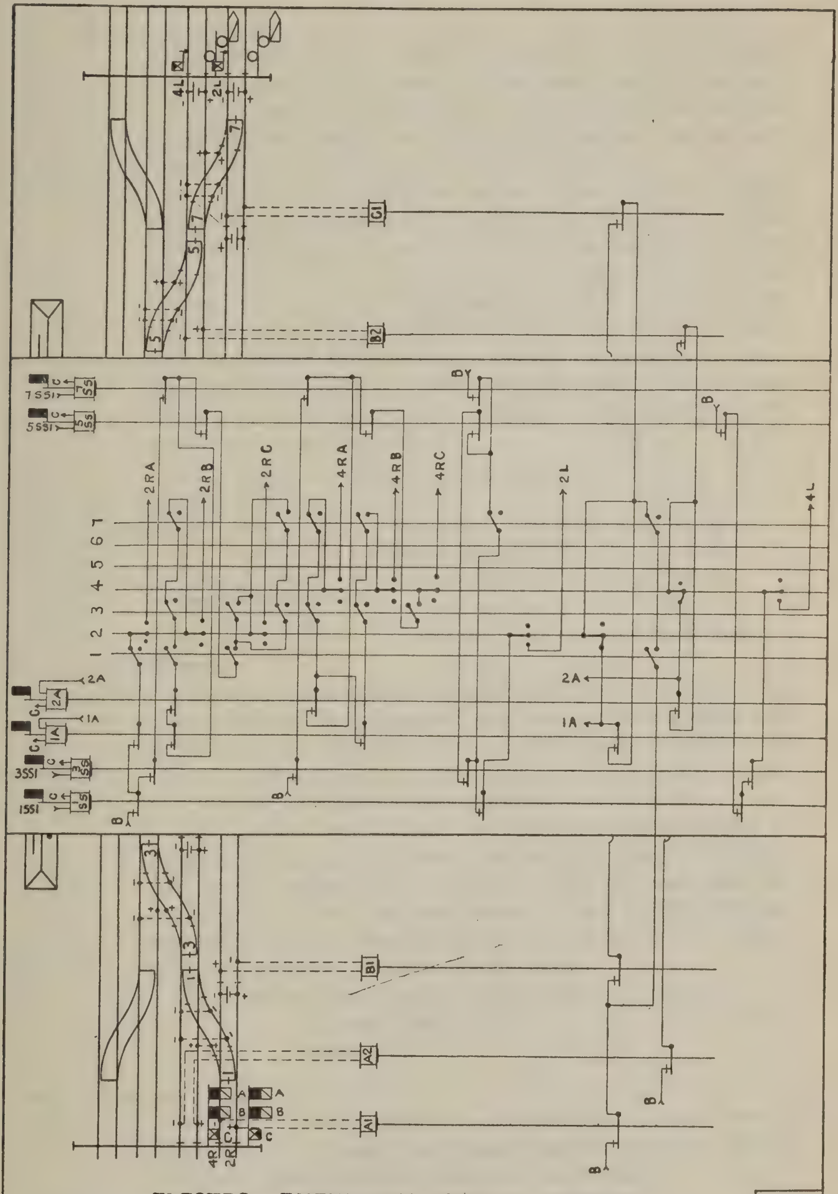
Circuit.—Section locking for single switch.


To Switch Indicating Indicator
B
C
R.I. Magnet
N.I. Magnet
Lock Magnet
Closed with Knob on Lever
B
C
C
C
R
L
N
B
ELECTRO PNEUMATIC
SECTION LOCKING
FOR
SINGLE SWITCH
RSA
1162
DEC. 1911

Signal circuit.—Selecting through switch levers.


4L
2L
7
5
G1
B2
7SS1
5SS1
SS
C
B
BY
2RA
2RB
2RC
4RA
4RB
4RC
2L
4L
1
2
3
4
5
6
7
2A
1A
3SS1
1SS1
3
1
B1
A2
A1
A
B
C
4R
2R

ELECTRO PNEUMATIC SIGNAL CIRCUIT
(SHOWING SECTION THROUGH SWITCH LEVERS AND S. S. INDICATORS)

DEC. 1911

RSA
1163

OF THE
UNIVERSITY

102. *Levers.*—Continued.

(f) Levers shall be five (5) feet ten and one-eighth (10 1/8) inches from center of fulcrum to end of handle.

(g) In machines of the same type all levers shall have equal and uniform throw and be so arranged that connections may be made to front or back of lever.

(h) Tail levers for pipe connections shall be drilled to provide for eight and three-fourths (8 3/4); nine and three-fourths (9 3/4), and ten and three-fourths (10 3/4) inch stroke. Tail levers for wire connections shall be drilled for eight and three-fourths (8 3/4); ten and three-fourths (10 3/4); twelve and three-fourths (12 3/4); fourteen and three-fourths (14 3/4) and sixteen and three-fourths (16 3/4) inch strokes and shackles shall be connected to tail levers with standard seven-eighths (7/8) inch pins for all wire lines.

LEADOUT AND GROUND WORK.

200. *Composition.*

Material.

Leadout shall be {
Rocking shaft.
Horizontal and vertical cranks.
Deflecting bar.
Deflecting bar and vertical crank. }

Field work.

(b) Down rods shall be vertical with offset jaws, so that they may be connected to levers for either eight and three fourths (8 3/4) inch or nine and three-fourths (9 3/4) inch stroke and connected to the eight and three-fourths (8 3/4) inch stroke holes.

(c) Leadout appliances shall be securely fastened to leadout supports with three-fourths (3/4) inch bolts with bolt heads underneath. Four (4) bolts shall be used for rocking shaft bearings, horizontal cranks, vertical cranks, deflecting bar and horizontal wheel stands; two (2) bolts shall be used for vertical wheel stands.

(d) Leadout supports shall be furnished by the .... in accordance with .... drawing .... dated ....

202. *Vertical cranks.*

Vertical cranks shall be eleven and three-fourths (11 3/4) by eleven and three-fourths (11 3/4) inches center to center, mounted on one-way stands.

203. *Deflecting bars.*

Deflecting bars shall be in accordance with Railway Signal Association drawings 1068 and 1069. 1912.

204. *Vertical wheels*

Vertical wheels shall be made of malleable iron and shall be ten (10) inches in diameter, mounted on one-way stands. Stands shall be drilled for bearings eight (8) inches and ten (10) inches above base, and bases cored for four (4) three-fourths (3/4) inch bolts, spaced six and three-fourths (6 3-4) inches by two and three-fourths (2 3/4) inches.

210. *Pipe.*

One (1) inch pipe, $\left\{\begin{array}{l}\text{steel}\\ \text{wrought iron}\end{array}\right\}$ couplings, plugs and rivets shall comply with Railway Signal Association specifications for "Pipe and couplings."

211. Pipe lines.

Material.

(a) One inch pipe shall be used for connections to switches, derails, movable wing and point frogs, detector bars, locks, bridge couplers, home and .... signals. Where solid connections are required one and eleven thirty-seconds (1 11/32) inch round iron shall be used unless otherwise specified.

Field work.

(b) Pipe lines shall be in true alignment, with nearest pipe not less than four (4) feet six (6) inches from gauge line, except where the line runs between tracks or permission to deviate is granted by the Purchaser. On drawbridges and approaches they shall be kept as far from gauge line as conditions will permit.

(c) Where practicable, pipes in main pipe line shall be run so that they will lead off on track side in regular order.

(d) Top of pipe carrier foundations in main pipe line shall be one-eighth (1/8) inch below base of rail where conditions will permit.

(e) Cranks, compensators and deflecting bars in main pipe run shall be so located as to leave field side clear for wires, trunking and additions.

(f) Pipe lines shall be laid two and three-fourths (2 3/4) inch centers and shall be supported on pipe carriers placed not more than seven (7) feet centers.

(g) With lever at the center of stroke the couplings in pipe line shall be located not less than twelve (12) inches from pipe carriers.

211. *Pipe Lines.*—Continued.

(h) Where so specified "I" beam track supports shall be used where pipe lines cross under tracks, and construction shall be in accordance with .... drawing .... dated ...., and shall be furnished in place by the Purchaser.

(i) Pipe lines running across tracks shall be arranged to permit standard spacing and proper tamping of ties, except where otherwise provided.

(j) Turns in pipe lines shall be made with deflecting bars, radial arms or cranks as follows:

Angle of deflection, degrees.	Bars.	Radius.
0 to 11	.... with tang ends.	....
11 to 33 1/2	22 1/2 deg. with eye ends.	72 inch.
33 1/2 to 56	45 deg. with eye ends.	36 inch.
56 to 78 1/2	67 1/2 deg. with eye ends.	24 inch.
78 1/2 to 90	90 deg. with eye ends.	18 inch.

Degrees.	Radial arms and cranks.
0 to 30	15 deg. radial arm cranks.
30 to 75	60 deg. acute angle cranks.
75 to 105	90 deg. right angle cranks.
105 to 140	120 deg. obtuse angle cranks.
140 to 180	180 deg. equalizing arms.

(k) Pipe lines shall be installed in accordance with Railway Signal Association compensation drawing 1102.

(l) Offsets in pipe lines shall be made in body of jaws, or an inserted rod one and eleven thirty-seconds (1 11/32) inch in diameter. The total offset between any two supports shall never exceed three and one-half (3 1/2) inches; minimum distance between ends of offset shall never be less than twice the amount of the offset. Offsets in cranks and compensators shall be avoided as far as practicable.

212. *Stuffing boxes.*

Material.

(a) One and one-fourth (1 1/4) inch stuffing boxes for pipe shall be of such design as to permit of standard facing of pipe lines, two and three-fourths (2 3/4) inches between centers, they shall have oil inlet and be attached to a two (2) inch pipe with standard pipe couplings.

Field work.

(b) Where specified, one (1) inch pipe shall be run inside of standard two (2) inch galvanized iron pipe

212. *Stuffing boxes.*—Continued.

filled with crude petroleum and provided at each end with a stuffing box.

213. *Pipe carriers.*

Material.

(a) Pipe carrier sides and bottom rollers shall be made of malleable iron.

(b) Pipe carriers for main pipe runs shall be of the antifriction type, and consructed of individual sides, top and bottom rollers; sides shall be connected together at top; in contact but not connected at bottom; bases shall be cored for two (2), one-half (1/2) inch lag screws five and one-eighth (5 1/8) inch centers.

(c) Transverse pipe carriers shall be in accordance with Railway Signal Association drawings 1072 and 1073.

(d) Strap pipe carriers shall be in accordance with Railway Signal Association drawing 1071.

(e) Pipe carriers for main pipe runs shall be fastened to foundations with two (2), one-half (1/2) by two and one-half (2 1/2) inch lag screws.

(f) Transverse pipe carrier bearers shall be fastened to foundations with two (2), five-eighths (5/8) by four (4) inch lag screws.

(g) Pipes leading across tracks shall be supported by transverse pipe carriers fastened to top of ties.

(h) Strap pipe carriers shall be fastened to foundations with two (2), one-half (1/2) by two and one-half (2 1/2) inch lag screws.

220. *Compensators.*

Material.

(a) Compensators shall be in accordance with Railway Signal Association drawings 1003, 1004, 1013, 1014 and 1025.

(b) Not more than one (1) horizontal, or more than two (2) vertical compensators shall be mounted on one (1) stand.

Field work.

(c) Compensation shall be provided for each pipe line more than fifty (50) feet in length and less than eight hundred (800) feet, with crank arms ten (10) by thirteen (13) inch centers. From eight hundred (800) to twelve hundred (1200) feet in length, crank arms shall be ten (10) by sixteen (16) inch centers. Pipe lines over twelve hundred (1200) feet in length shall be provided with ad-

220. *Compensators.*—Continued.

ditional conpensators. Not more than seven hundred twenty-five (725) feet of pipe shall be compensated by an eleven and three-fourths (11 3/4) by eleven and three-fourths (11 3/4) inch crank.

225. *Horizontal Cranks.*

Material

(a) Horizontal cranks shall be in accordance with Railway Signal Association drawings 1005, 1007, 1008 and 1011.

Field work.

(b) Cranks shall be drilled eleven and three-fourths (11 3/4) by eleven and three-fourths (11 3/4) inch centers.

(c) Not more than two (2) cranks shall be mounted on the same base and not more than one (1) crank mounted on one (1) center.

230. *Jaws and lugs.*

Material.

(a) Jaws and lugs shall be in accordance with Railway Signal Association drawings 1016, 1017, 1018, 1019, 1020, 1021, 1022, 1023 and 1195. 1912.

Field work.

(b) Solid jaws shall be used for connections to all cranks, compensators, deflecting bars, couplers, rail locks, pipe connected levers and balance levers, unless otherwise specified.

(c) Screw jaws shall be used as follows: One (1) for each switch connection to bolt lock, front rod, lock rod, switch and lock movement, and detector bar connections; in signal line on each side of bolt lock and in each high signal down rod; they shall be located as close as practicable to the unit to be adjusted.

235. *Pipe and wire adjustments.*

Material.

(a) Pipe and wire adjusting screws shall be in accordance with Railway Signal Association drawings 1001 and 1002.

Field work.

(b) Pipe adjusting screws shall be placed in each pipe line as follows: One (1) for each facing point lock, switch and lock movement, pipe connected high home, dwarf signals, bridge lock and couplers; and two (2) for each connection made by bridge coupler; they shall be

235. *Pipe and wire adjustments.*—Continued.

located as near as practicable to unit to be adjusted without having them directly under the rails, guard rails, frogs, switches or bridge guards.

(c) Switches, derails, movable wing frogs and movable point frogs, shall be provided with switch adjustments fastened to the head rods.

(d) Wire lines for wire connected distant signals, shall be provided with two (2) adjusting screws for each wire, one (1) in the interlocking station and one (1) at base of signal mast.

(e) Wire lines for wire connected dwarf signals shall be provided with one (1) adjusting screw for each wire, placed in the interlocking station.

(f) Switches, movable wing frogs, movable point frogs and split point derails shall be adjusted to a throw of .... (..) inches.

241. *Wire lines.*

Material.

(a) Signal wire shall be hard drawn, galvanized steel No. 8 B.W.G. (.165 inch in diameter), and shall comply with Railway Signal Association specifications for "Galvanized steel signal wire."

Field work.

(b) When wire connected, two (2) wires shall be used for operating each signal the normal operating wire shall have two (2) inches more stroke than the reverse operating wire.

(c) Wire lines shall be carried in wire carriers placed not more than twenty-one (21) feet apart. Where they run next to pipe lines, the wire carriers shall be attached to the pipe carrier foundations.

(d) Where wire carriers are attached to independent foundations they shall be placed not less than six (6) feet from gauge of nearest rail, where practicable.

(e) Where wire lines are located on curves the carrier shall be placed at the proper angle to prevent wire leaving groove of pulley.

(f) Turns in wire lines shall be made around chain wheels with a continuous piece of chain.

(g) Where specified, wire lines shall be run inside of three-eighths (3/8) inch galvanized iron pipe filled with crude petroleum and shall be provided at each end with a stuffing box. Oil inlet shall be provided.

270. *Foundations.*—Continued.

(b) Foundations shall be set parallel to track, except as otherwise specified.

(c) Dimensions of concrete foundations shall be as follows:

	Top.	Base.	Depth.
Cranks	20″x18″	36″x34″	36″
Compensators	34″x18″	50″x34″	36″
Two way chain wheels.....	22″x18″	38″x34″	36″
Dwarf signal	30″x16″	30″x16″	36″
Ground mast	26″x26″	36″x36″	48″
Ground mast with mechanism in base.......	30″x36″	42″x48″	48″
Bracket post	38″x38″	48″x48″	60″

(d) Concrete foundations shall stand until properly set before any apparatus is connected thereto or placed thereon.

(e) Foundations shall be so constructed that apparatus can be removed without disturbing them.

(f) Foundations shall conform to .... drawings ....

(g) The dimensions for concrete foundations are adaptable to level and solid ground. The Purchaser and Contractor shall jointly decide when deviations from specified sizes are necessary.

271. *Signal foundation bolts.*

(a) Foundation bolts for ground masts shall be one (1) inch by thirty-six (36) inches.

(b) Foundation bolts for bracket signal posts shall be one and one-half (1 1/2) inches by forty-eight (48) inches.

272. *Pipe line foundations.*

Material.

(a) Pipe carrier foundations shall consist of:

1. Iron piers with .... tops and bottoms.
2. Concrete piers with .... tops and bottoms.
3. ....

(b) Iron pipe carrier piers shall be in accordance with Railway Signal Association drawing 1109.

(c) Concrete pipe carrier piers shall be in accordance with Railway Signal Association drawing 1080.

Field work.

(d) One (1) concrete pier shall be used for each pipe carrier foundation up to twenty-five and three-fourths

272. *Pipe line foundations.*—Continued.

(25 3/4) inches long, and one additional pier for each additional thirty-four (34) inches or fraction thereof.

(e) Two (2) piers shall be used for each iron pier pipe carrier foundation up to forty-five (45) inches long and one (1) additional pier shall be provided for each additional thirty-six (36) inches or fraction thereof and intermediate piers shall be inverted.

(f) Cranks, compensators and bolt locks shall be arranged with slot for three-fourths (3/4) inch bolts and set in concrete. Plank to hold dwarf signals, deflecting bars, wheels, etc., shall be fastened in a similar manner.

273. *Plank and stakes.*

(a) Plank for leadouts, leadoffs, dwarf signals, deflecting bars, wheels, etc., shall be three and three-fourths (3 3/4) inch by twelve (12) inch .... lumber dressed two (2) sides.

(b) Wooden stakes for wire lines shall be .... lumber three (3) by four (4) inches by five (5) feet with seven (7) inch point.

280. *Concrete.*

Concrete shall comply with Railway Signal Association specifications for "Concrete."

290. *Boxing.*

Where boxing is specified, it shall be made of two (2) by eight (8) inch .... lumber, dressed one (1) side. Where bottom in boxing is specified, it shall be made of one (1) inch .... rough lumber; through highways the sides shall be made of three (3) by six (6) inch and three (3) by ten (10) inch .... lumber and shall be spiked to the foundation tops. Four (4) by twelve (12) inch .... lumber shall be used for tops and it shall be cut diagonally and not nailed to sides.

SWITCHES.

300. *Switch mechanism.*

Material.

(a) Switch mechanisms shall perform their normal operations in the following sequence:

1. Unlock switch.
2. Throw switch.
3. Lock switch.

(b) Switch and lock movement shall be provided with staggered locking for normal and reverse position of points.

313. *Bolt lock stands and bars.*—Continued.

lock shall be made of mild steel three-fourths by two by thirty (3/4"x2"x30") inches with two (2) inch notch.

Field work.

(c) Switch bar in bolt lock shall be connected to an independent lug on switch point; such lug to be located not more than two (2) feet from point of switch.

(d) Signal bar of bolt lock shall form a part of the pipe or wire line operating the signal.

320. *Tie, butt and riser plates.*

Material.

(a) Tie plates shall be wrought iron one-half (1/2) inch by six (6) inches wide.

(b) Butt plates shall be wrought iron three-fourths by two and one-half by six (3/4"x2 1/2"x6") inches and drilled for two (2) three-fourths (3/4) inch rivets spaced three and one-half (3 1/2) inch centers.

(c) Riser plates shall be wrought iron three-eighths by six by ten (3/8"x6"x10") inches, drilled for two (2) three-fourths (3/4) inch rivets four (4) inches between centers and eight and one-half (8 1/2) inches from the rail end of the plate and one (1) three-fourths (3/4) inch rivet one and one-half (1 1/2) inch from the rail end of the plate.

Field work.

(d) Three (3) tie plates shall be used for all switches and derails and shall be located so that one (1) plate shall be placed on point tie, and one (1) on nearest tie on either side.

(e) Four (4) tie plates shall be used for each set of movable point frogs and shall be located so that one (1) plate will be placed on point tie and one (1) on first tie back of the point tie for each pair of points.

(f) Tie plates shall be fitted in place and securely fastened to the ties with four (4) three-fourths (3/4) by four (4) inch lag screws.

330. *Tie straps.*

Material.

(a) Tie straps shall be one-half (1/2) by two (2) inch wrought iron.

Field work.

(b) Tie straps shall be used at all switches, derails, movable wing frogs and movable point frogs, to tie all crank, rocking shaft, point and intermediate ties to-

330. *Tie straps.*—Continued.

gether, placed on top of ties and fastened to each tie with one (1) three-fourths (3/4) by four (4) inch lag screw.

DETECTOR BARS.

340. *Detector bars.*

Material.

(a) Outside detector bars shall be {three-eighths (⅜) / one-half (½)} inch thick and in accordance with Railway Signal Association drawing 1098. 1912.

Field work.

(b) Bars shall be located as shown on .... drawing ...., unless otherwise specified.

(c) Detector bars shall be arranged to give .... (..) feet continuous protection for all switches, derails, movable wing frogs, and movable point frogs.

(d) Detector bars, when practicable, shall be so connected that the unlocking movement when switch is in the main line position shall be in the reverse direction to the facing movement of traffic over the points.

342. *Rail clips.*

Material.

(a) .... type rail clips shall be furnished.

(b) Fifty-three (53) feet bars shall be mounted on sixteen (16) rail clips and a proportionate number of clips shall be used for longer or shorter bars.

Field work.

(c) Center of rail clips shall be placed eight (8) inches and twenty-six (26) inches respectively from end and the remaining clips approximately three (3) feet nine (9) inches apart.

342. *Rail clips.*—Continued.

(d) Bars shall rise a minimum of three-fourths (3/4) inch above top of rail at every point during the locking and unlocking of the switch, and shall rest one-fourth (1/4) inch below top of rail at every point when lever travel is completed.

343. *Stops and guides.*

Where radial arm clips are used combination bar stops and guides shall be provided, one (1) for every ten (10) feet of bar (equally spaced) and not less than two (2) such stops on one (1) bar.

344. *Driving pieces.*

Material.

(a) Driving pieces shall be wrought iron or steel, arranged for one and eleven-thirty-seconds (1 11/32) inch jaw connections. The part where the jaw is connected shall be three-fourths by two by three (3/4x2x3) inches, and part riveted to bar shall be one-half by two by six (1/2x2x6) inches, drilled for three (3) one-half (1/2) inch rivets, one (1) inch from end and two (2) inches between centers of holes. Offset from bar to jaw connection shall be one and one-half (1 1/2) inches.

Field work.

(b) Driving pieces shall be placed midway between two (2) clips in space not occupied by joint in bar, and the driving rod shall have a length of not more than seven (7) feet unsupported.

345. *Rocking shafts and fittings.*

Material.

(a) Rocking shafts and fittings shall be in accordance with Railway Signal Association drawings 1060, 1061 and 1062. 1912.

345. *Rocking shafts and fittings.*—Continued.

(b) Rocking shaft bearings shall be made of cast iron and fastened to a one by three by twenty-four (1x3x24) inches wrought iron or steel bearer drilled at each end for two (2) three-fourths (3/4) inch bolts; the center of first hole shall be two (2) inches from end and holes shall be spaced three (3) inches between centers.

Field work.

(c) Rocking shafts shall be supported by a bearing at each end and not more than six (6) feet of shaft shall be unsupported.

(d) Rocking shaft bearers shall be securely bolted to ties with four (4) three-fourths (3/4) inch bolts. The maximum spacing of bearers shall be six (6) feet centers.

348. *Section locking circuits.*

Section locking circuits will .... be required

in { addition to / lieu of } detector bars.

SIGNALS.

400. *Type and assembly.*

(a) Signals shall be of the semaphore type with arm travel .... (..) degrees in the .... { right* / left** } quadrant.

*Adopted by the Railway Signal Association.
**Recommended for Interurban lines.

(b) The type of signals (as shown by the Railway Signal Association symbols) and location of signals shall be in accordance with .... drawing ....

(c) Signals and fittings shall conform to Railway Signal Association material specifications.

(d) The spacing of arms on all masts shall be in accordance with Railway Signal Association drawings 1035 or 1037.

(e) Dwarf signals shall be mechanically locked in the horizontal position of the arm except as otherwise specified.

401. *Ground signals.*

The general design, dimensions and structure shall be in accordance with Railway Signal Association drawing 1035.

402. *Bracket signals.*

(a) Bracket signal posts of pipe shall be made of .... (..) inch and .... (..) inch wrought iron pipe with water-tight joints, mounted in Railway Signal Association base drawing 1036. 1912.

(b) Top of crosstrees shall be .... (..) feet .... (..) inches above base of bracket post.

(c) Bracket signal posts of channel column construction shall be in accordance with Railway Signal Association drawing 1032. 1912.

403. *Bracket and bridge signals.*

Bracket and bridge signal masts shall be made of five (5) inch wrought iron pipe, mounted in Railway Signal Association base drawing 1034.

405. *Dwarf signals.*

(a) Dwarf signals shall be of cast iron in accordance with Railway Signal Association drawing 1097. 1912.

(b) Use light, easily breakable, lead nuts to fasten dwarf signal base to foundation bolts.

410. *Semaphore spectacles.*

(a) High signal spectacles shall be in accordance with Railway Signal Association drawing {1040 / 1041} with spectacle rings Railway Signal Association drawing 1042.

(b) Back lights {shall / shall not} be furnished.

(c) Back light spectacle shall be designed for one (1) .... glass.

(d) Dwarf signal spectacles shall be {two (2) / three (3)} light in accordance with Railway Signal Association drawing 1233. 1912.

415. *Signal blades.*

(a) High signal blades shall be in accordance with .... drawing ...., and shall be made of well seasoned white ash or ....

(b) Dwarf signal blades shall be flexible or hinged with dimensions in accordance with .... drawing ....

420. *Signal arm shafts.*

(a) High signal semaphore shafts shall be made of steel, not less than one and one-fourth (1 1/4) inches in diameter.

(b) Semaphore castings shall be mounted on square section of shaft. Operating arm shall be mounted on square section or otherwise securely fastened.

(c) Dwarf signal semaphore shafts shall be made of cold rolled steel .... (..) inches square.

425. *Roundels.*

Roundels shall comply with Railway Signal Association specifications and shall be supplied as follows:

	Color.	Dia. inches.
Caution	....	(..)
Stop, for high signal....	....	(..)
Stop, for dwarf signal....	....	(..)
Proceed, for high signal..	....	(..)
Proceed, for dwarf signal	....	(..)
Back light	....	(..)

430. *Lamps.*

(a) Lamps shall be { oil.
convertible.

(b) Oil lamps shall be in accordance with Railway Signal Association drawing 1100.

(c) Convertible lamps shall be equipped with .... (..) incandescent lamps and marine receptacles, in accordance with .... drawing ...., and with oil fonts and burners.

(d) .... (..) extra incandescent lamps shall be furnished.

435. *Signal locations.*

(a) Signal masts shall be on the right of the track governed and adjacent thereto, where practicable.

(b) Signal arms on tangent shall be at right angles to track governed when sufficient approach is on tangent. On curves signal arms shall be at right angles to imaginary line drawn from the signal to the point where the best view can be obtained by the engineman, as decided by the Purchaser.

(c) Signals placed between tracks on tangent shall be set so that the center of mast shall be midway between tracks. Signals placed between tracks on curves shall be set off the center line between tracks and towards the center of the curve two and one-half (2 1/2) inches for each one (1) inch superelevation.

(d) Before any signals are erected, the Purchaser shall, in the presence of the Contractor's foreman (or other representative), locate each signal.

(e) Outside of tracks, dwarf signals shall be placed .... (..) feet, ground masts .... (..) feet and bracket posts .... (..) feet from nearest rail.

(f) Bridge masts shall be located on .... chord of bridge.

(g) Base of dwarf masts shall be .... (..) inches below base of rail. Base of high signals shall be .... (..) inches below base of rail.

(h) The balance levers on wire connected high signals located between tracks shall be set parallel to tracks.

800. *Paint.*

Material.

(a) Purchaser will indicate here the kind of paint that shall be required:

....
....
....

Field work.

(b) Surfaces covered with rust, grease, dirt or other foreign substances, shall be thoroughly cleaned before paint or oil is applied.

(c) Paint shall not be applied to outside surfaces in freezing weather, nor to wet surfaces, nor until previous coating has thoroughly dried.

(d) Finishing coats shall not be applied until after the expiration of forty-eight (48) hours after the previous coating has been applied.

(e) Paints mixed on the ground shall be applied within three (3) hours after the pigment and oil are mixed.

(f) Priming coats shall be applied as soon as is consistent with the progress of the work.

(g) Second coat shall be applied in sufficient time for the third coat to be applied and dry when the installation is completed.

810. *Iron work.*

(a) Iron work (except machine, tie plates, iron foundation piers and air pipe line) not galvanized shall be painted one (1) coat of red lead and raw linseed oil and two (2) finishing coats.

(b) The following specific finishing coats shall be used:

	Kind of paint.	Color.
Signal bridges and brackets	....	....
Signal masts	....	....
Dwarf signals	....	....
All connections	....	....

(c) Outside iron connections, switch and signal fittings, not machine finished, shall be dipped in raw linseed oil before shipment from works.

820. *Machine.*

Machine and lever handles shall be of Purchaser's standard color, as follows:

	Color.
Home signal levers	....
Distant signal levers	....
Lock levers	....
Other working levers	....
Spare levers	....
Hand releases	....

830. *Wood work.*

Exposed wood work shall be given one (1) priming coat and finishing coats as follows:

	Kind of paint.	Color.	Number of coats.
Home signal blades	....	....	....
Dwarf signal blades	....	....	....
Distant signal blades	....	....	....
Trunking, junction boxes, etc.	....	....	....
Foundation tops and bottoms	....	....	....

840. *Buildings*

Interlocking station and other buildings, if constructed of wood shall receive one (1) priming coat and two (2) finishing coats. The priming coat shall consist of .... and, when thoroughly dry, two (2) coats of .... in the following tints, shall be applied:

....
....
....

SPECIAL ITEMS.

900. ....
....
....

925. *Locks.*

Purchaser's standard locks shall be used where specified.

926. *Number plates and numbers.*

(a) Number plates.

....
....
.... 1912.

(b) Numbers.

....
....
.... 1912.

950. *Drawbridges.*

Interlocking for drawbridges shall comply with Railway Signal Association recommendations.

SPECIFICATIONS FOR GRAY IRON CASTINGS.

1. *Material.*

(a) Gray iron casting must be of good sound iron, free from flaws, blow holes, fins, cold shuts, or shrinkage cracks. They must conform to dimensions shown on drawings and must not exceed the specified weight, when weight is specified.

(b) Castings having any section less than one-half (1/2) of an inch thick shall be known as light castings.

(c) Castings in which no section is less than two (2) inches thick shall be known as heavy castings.

(d) Medium castings are those not included in the above definitions.

2. *Chemical properties.*

(a) Light castings, sulphur not over eight hundredths (0.08) of one per cent.

(b) Medium castings, sulphur not over ten hundredths (0.10) of one per cent.

(c) Heavy castings, sulphur not over twelve hundredths (0.12) of one per cent.

3. *Physical properties.*

(a) Transverse test. The breaking strength of the arbitration bar under transverse load shall not be under

Twenty-five hundred (2500) lbs. for light castings;

Twenty-nine hundred (2900) lbs. for medium castings;

Thirty-three hundred (3300 lbs., for heavy castings, with load applied at center and the points of support twelve (12) inches apart.

(b) The Manufacturer's pattern number must appear on each casting and be so located that it will not wear off or interfere with the fitting of other parts to the casting.

(c) Castings will be inspected at the shops of the Manufacturer, and those which fail to meet the above requirements will be rejected. Test of test specimens may be made at the place of manufacture, the Manufacturer to furnish suitable apparatus to make the test without expense to the Purchaser; or these tests may be made at destination, if the Purchaser so desires, in which case the foundry will furnish two arbitration bars for each melt used in filling the shipment.

(d) A blue print showing the arbitration bar and its mold will be supplied to those filling orders for gray iron castings for the Purchaser, upon request.

Oil.
Illuminating.
Specifications.

Petroleum.
Asphaltum.
Specifications.

SOFT STEEL, ONE INCH—Specifications.

Pipe.

WROUGHT, ONE INCH—Specifications.

Poles.
White Cedar.
Specifications.

SPECIFICATIONS FOR EASTERN WHITE CEDAR POLES.

1912.

1. *Intent.*

The material required under these specifications is to be used for carrying aerial wires, and for other purposes.

2. *General.*

Poles shall be of the best quality of either seasoned or live green cedar of the dimensions hereinafter specified. Seasoned poles shall have preference over green poles, provided they have not been held for seasoning long enough to have developed any of the timber defects hereinafter referred to. All poles shall be reasonably straight, well proportioned from butt to top, squared at both ends and with all knots and limbs closely trimmed.

3. *Classes of poles.*

Poles shall be classed and used according to the line wire conductors they carry, or ultimately will carry:

1. Class A, over forty (40) wires.
2. Class B, from twenty-one (21) to forty (40) wires.
3. Class C, from thirteen (13) to twenty (20) wires.
4. Class D, from seven (7) to twelve (12) wires.
5. Class E, from three (3) to six (6) wires.
6. Class F, two (2) wires carried on brackets.

4. *Dimensions of poles.*

(a) The minimum dimensions in inches of poles shall be in accordance with the following table, the top measurement being the circumference at the top of the pole, and the butt being the circumference six (6) feet up from the butt end:

Length of Pole	CLASS A.		CLASS B.		CLASS C.		CLASS D.	CLASS E.	CLASS F.
in feet.	Top.	Butt.	Top.	Butt.	Top.	Butt.	Top.	Top.	Top.
20					18¾	27	17¼	15½	15½
22			22	30	18¾	28½	17¼	15½	15½
25	24	36	22	32	18¾	30	18¾	17¼	15½
30	24	40	22	36	18¾	33	18¾	18¾	15½
35	24	43	22	38	18¾	36	18¾	18¾	17¼
40	24	47	22	43	18¾	40	18¾	18¾	17¼
45	24	50	22	47	18¾	43	22	22	
50	24	53	22	50	18¾	46	22	22	
55	24	56	22	53	18¾	49	22	22	
60	24	59	22	56					

4. *Dimensions of poles.*—Continued.

(b) When the dimension at the butt is not given, the poles shall be reasonably well proportioned throughout their entire length.

(c) No poles shall be over six (6) inches longer, or three (3) inches shorter, than the length for which it is accepted. If any pole is more than six (6) inches longer than is required, it shall be cut back.

5. *Quality of timber.*

(a) *Dead poles.* The wood of a dead pole is grayish in color. The presence of a black line on the edge of the sapwood (as seen on the butt) also shows that a pole is dead. No dead poles, and no poles having dead streaks covering more than one-fourth (1/4) of their surface, shall be accepted. Poles having dead streaks covering less than one-fourth (1/4) of their surface shall be larger than otherwise required.

(b) *Fire killed or river poles.* No dark red or copper-colored poles which, when scraped, do not show good live timber shall be accepted.

(c) *Twisted, checked or cracked.* No poles having more than one (1) complete twist for every twenty (20) feet in length, no cracked poles and no poles containing large season checks shall be accepted.

(d) *"Cat faces."* No poles having "cat faces," unless they are small and perfectly sound and the poles have an increased diameter at the "cat face," and no poles having "cat faces" near the six (6) foot mark or within ten (10) feet of their tops, shall be accepted.

(e) *Shaved poles.* No shaved poles shall be accepted.

(f) *Miscellaneous defects.* No poles containing sap rot, evidence of internal rot as disclosed by a careful examination of all black knots, hollow knots, woodpecker's holes, or plugged holes, and no poles showing evidence of having been eaten by ants, worms or grubs shall be accepted under these specifications, except that poles containing worm or grub marks below the six (6) foot mark will be accepted.

(g) *Crooked poles.* No poles having a short crook or bend, a crook or bend in two places or a reverse curve shall be accepted under these specifications. The amount of sweep, measured between the six (6) foot mark and the top of the pole, that may be present in poles acceptable under these specifications is shown in the following table:

5. *Quality of timber.*—Continued.

Length of pole in feet.	Maximum sweep in inches.
35	10½
40	12
45	9
50	10
55	11
60	12

(h) *Defective tops.* Poles having tops of the required dimensions must have sound tops. Poles having tops one (1) inch or more above the requirements in circumference may have one (1) pipe rot not more than one-half (1/2) inch in diameter. Poles with double tops or double hearts shall be free from rot where the two parts or hearts join.

(i) *Defective butts.* No poles containing ring rot (rot in the form of a complete or partial ring) shall be accepted.

1. Poles having hollow hearts may be accepted under the conditions in the following table:

Average Diameter of Rot.	ADD TO BUTT. REQUIREM'TS OF 20, 22, 25 and 30′ Poles.	35, 40 and 45′ Poles.	50, 55 and 60′ Poles.
2 inches	nothing	nothing	nothing
3 inches	1 inch	nothing	nothing
4 inches	2 inch	nothing	nothing
5 inches	3 inch	1 inch	nothing
6 inches	4 inch	2 inch	1 inch
7 inches	reject	4 inch	2 inch
8 inches	reject	6 inch	3 inch
9 inches	reject	reject	4 inch
10 inches	reject	reject	5 inch
11 inches	reject	reject	7 inch
12 inches	reject	reject	9 inch
13 inches	reject	reject	reject

2. Scattered rot, unless it is near the outside of the pole, may be estimated as being the same as heart rot of equal area.

(j) *Wind shakes.* Poles with cup shakes (checks in the form of rings) which also have heart or star checks may be considered as equal to poles having hollow hearts of the average diameter of the cup shakes.

6. *Overshipment.*

Overshipment of an order will be entirely at the risk of the dealer furnishing the material.

7. *Loading.*

Poles shall be compactly loaded on cars and fastened in such a manner that they will not shift or jar off.

8. *Marking.*

At least six poles in every carload, or all of them if there are no more than six in the shipment, shall be plainly marked to show the car number in which shipped, the number of poles on the car, the Purchaser's order and requisition numbers on which furnished, the name of the Consignor and the address of the Consignee.

9. *Inspection.*

(a) Material will usually be inspected in the yards of the dealer. The dealer shall notify the Purchaser at least two (2) days before the poles will be ready for shipment and shall furnish, free of cost to the Purchaser, all assistance necessary to make a satisfactory inspection.

(b) If the Purchaser prefers to inspect the poles after they reach destination, the dealer will be notified by him to ship them with the understanding that if they fail to meet the requirements of these specifications they will be rejected.

(c) Inspection reports showing the result of the inspection will be mailed to the dealer within two weeks after unloading and inspecting the material, when inspected at destination.

10. *Acceptance.*

(a) If, on inspection, the material is found to meet these specifications, it will be accepted. If the material is not in accordance with these specifications, it will be rejected and the dealer shall pay all freight charges.

(b) Rejected material will be held for thirty (30) days, from the date of the inspection report, free of charge, during which time the dealer is expected to give disposition for it. Failure of the dealer to give the Purchaser such disposition will be considered as authority from the dealer to make a charge for storage of five (5) cents per pole per day, after the expiration of the thirty (30) days.

Relays.

LIFTING ARMATURE, NEUTRAL TYPE, DIRECT CURRENT —Specifications.

Releases.

MECHANICAL AND ELECTRICAL—Specifications.

Roundels, Lenses and Slides. Specifications.

SPECIFICATIONS FOR LIFTING ARMATURE, NEUTRAL TYPE, DIRECT CURRENT RELAYS.

1912.

1. *Purpose.*

These specifications are intended to provide for lifting armature, neutral type, direct current relay, for railway signaling.

2. *General design.*

(a) Relays shall be of a general design approved by the Purchaser.

(b) All moving parts shall be enclosed in a weatherproof, transparent, dustproof case, ventilated or non-ventilated as specified.

(c) The outside dimensions of complete relays shall not exceed the following:

	1 to 4 fingers. inches.	5 and 6 fingers. inches.	7 and 8 fingers. inches.
Height,	9½	9½	9½
Length,	7½	10	12½
Width,	7½	7½	7½

Note.—The length is the dimension parallel with the armature, and width is the dimension parallel with the contact fingers.

3. *Material and workmanship.*

Material and workmanship shall be of the best quality and free from defects.

4. *Finish.*

(a) Metal parts shall be protected against corrosion except when such protection will interfere with the proper functions of the relay. The armature and the part of the cores that are in the sealed portion of the relay shall be lacquered.

(b) Material used for protection against corrosion shall not melt or flake off under ordinary conditions, between temperatures of thirty (30) degrees below and one hundred and fifty (150) degrees above zero (0) degrees Fahr.

5. *Mounting of armature supports and cores.*

The armature supports and cores shall be mounted in such a manner that the position of the cores relative to each other, to the armature supports and to the fixed part of the contacts shall always be maintained.

6. *Armature supports.*

(a) Armature journals shall be hard-drawn phosphor bronze. They shall be cylindrical, not less than one-sixteenth (1/16) inch in diameter and one-eighth (1/8) inch long. They shall fit tightly in their supports, be suitably secured and so constructed that they can exert no pressure on the armature through improper adjustment.

(b) The armature bearings shall be hard brass. They shall be cylindrical, not less than one-eighth (1/8) inch long, and not more than two one-thousandths (.002) inches larger diameter than the journal.

(c) The end play of the armature shall be not less than ten one-thousandths (.010) inch and not more than twenty one-thousandths (.020) inch.

7. *Air gap.*

(a) A minimum actual air gap between the armature and cores shall be insured by the use of a non-adjustable hard bronze stop pin so placed that its position relative to the armature shall be fixed and so that when the armature is picked up it will strike against the stop near the edge opposite the bearings and midway between the cores.

(b) The air gap for relays with two (2) fingers shall be not less than twenty one-thousandths (.020) inch and for relays with three (3) or more fingers not less than fifteen one-thousandths (.015) inch.

8. *Nut locks.*

Nuts and screws in moving parts shall be securely locked to prevent loosening.

9. *Magnet coils.*

(a) Magnet coils shall be made so that they can be easily removed and replaced without removing the cores, and when in place shall be fixed to prevent vibration.

(b) Insulation shall be applied before the coils are placed on the cores.

(c) Wire for magnet coils shall be soft-drawn copper covered with a good quality of silk, cotton or equally good insulation.

(d) Except when enameled wire is used, coils shall be impregnated to comply with the Railway Signal Association specifications for "Impregnation treatment of coils and windings."

(e) The connecting terminals of magnet coils shall be joined by a substantial binding post. The terminal wires of magnet coils shall be not smaller than number twenty

9. *Magnet coils.*—Continued.

(20) B. & S. gauge soft-drawn copper, suitably protected from mechanical injury.

(f) The magnet coils shall be encased in some hard insulating material which will not be affected by atmospheric conditions, and this casing shall be fixed in its relation to the coils.

(g) Resistance of coils shall not vary more than five (5) per cent. from that specified.

10. *Contacts.*

(a) Unless otherwise specified, one element of the front contact shall be graphite (not plated), which shall be held in place without plating, brazing or soldering, and the other element of the front contact shall be $\left\{\begin{array}{l}\text{silver.}\\\text{platinum.}\end{array}\right.$ When silver is specified it must be at least equal in purity and quality to coin silver. Both elements of back contacts shall be chemically pure $\left\{\begin{array}{l}\text{silver.}\\\text{platinum.}\end{array}\right.$

(b) Each contact shall be designed to carry not more than five (5) amperes at a potential not to exceed thirty (30) volts.

(c) The resistance of cleaned front contacts shall not exceed thirteen one-hundredths (.13) ohm.

(d) The movable parts of contacts shall be attached to flexible metal parts that shall be of such material that they will hold their adjustment, and the flexible parts shall be attached to fingers that are heavy enough so that they will not spring on account of contact pressure.

(e) The flexible part shall be heavy enough to exert a pressure of not less than one (1) ounce against the fixed part of the contact when the armature is against the stop.

(f) Some arrangement shall be provided to prevent contacts vibrating during shipment.

11. *Flexible connections.*

The flexible conductor connecting the binding post and contact finger shall be formed and attached so as not to decrease the torque of the armature. This conductor shall be of a section to carry ten (10) amperes continuously without injury.

12. *Binding posts.*

(a) Binding posts shall be of brass and so constructed that they cannot be turned in the base or frame to which they are fastened. The threaded part, nuts and washers,

12. *Binding posts.*—Continued.

shall be in accordance with Railway Signal Association drawing 1070.

(b) Binding posts supporting the fixed parts of front and back contacts shall be fastened in their supports in such a manner as to preclude adjustment of any kind without first breaking the seal of the relay.

(c) Binding posts shall be arranged so that the wires connecting to them will be held in such a manner that shrinkage of the binding post support will not loosen the connection.

(d) Binding posts shall be so spaced that they will be separated by not less than three-eighths (3/8) inch air space.

13. *Insulation.*

(a) An insulation equivalent to not less than three-eighths (3/8) inch air space shall be provided between any part of the relay carrying current and any other metal part. This insulation shall withstand a test of an alternating current of not less than three thousand (3000) volts applied for at least two (2) seconds.

(b) Varnished paper or any similar material, or any material that will be affected by moisture or by change in temperature between thirty (30) degrees below and one hundred and fifty (150) degrees above zero (0) degree Fahr. shall not be used as an insulator for binding posts or contact fingers.

(c) When varnished cloth is used, it shall be in tubes having not less than one-thirty-second (1/32) inch walls.

14. *Magnetic iron test.*

The Purchaser may use any means he desires to satisfy himself that the proper grade of iron has been used in the magnetic circuit.

Armature torque.

(a) The torque of the armature shall be such that the value of the current at which it will drop away without contact pressure will not be less than fifteen (15) mil-amperes for a four (4) ohm relay.

(b) This test shall be made as follows: The armature shall be brought to the minimum air gap and a current of three hundred (300) mil-amperes applied to the coils and gradually reduced until the armature drops away.

16. *Adjustment.*

(a) Relays shall be adjusted so that when tested in the manner given below, the operating current values and contact opening shall be as follows:

Resistance of Relay Coils.	Four Ohms.	
	Two fingers.	Four fingers.
Minimum drop away with contact pressure	.035	.037
Maximum pick up............	.072	.078
Maximum working current ...	.078	.092
Contact opening..............	.050	.050

(b) Tests shall be made on relays that are assembled ready for service.

(c) An initial current of three hundred (300) milamperes shall be applied to the coils and then reduced until the armature drops away. This value of the current shall be the drop away with contact pressure.

(d) The circuit shall then be broken and current shall again be applied to the coils and increased until the armature is attracted. This value of the current shall be the maximum pick-up.

(e) The current shall then be increased until the armature is against the stop; this value of the current shall be called the working current.

17. *Sealing and calibration record.*

(a) The enclosure containing the moving parts of the relay shall be sealed with the Manufacturer's seal.

(b) The enclosure shall contain, in a location where it can be readily seen with the relay in its operating position, the following data:

1. Manufacturer's name.
2. Serial number of relay.
3. Resistance of coils.
4. Date of specifications.
5. Identification of tester.

18. *Inspection and tests.*

(a) The Purchaser shall be privileged to make such inspection as he desires of the material used in the construction of the relays.

(b) The Manufacturer shall provide all labor and apparatus for making the required tests when tests are made at the factory.

18. *Inspection and Tests.*—Continued.

(c) Tests may be made on relays upon their arrival at destination.

19. *Packing and marking.*

Relays shall be packed in strong packages, containing not more than four (4) relays, in such a manner that breakages are not liable to occur. The top and one end of each package shall be marked plainly with the warning, "Glass, Handle with Care;" and there shall be plainly marked on each package:

1. Address of Consignee.
2. Purchaser's order and requisition numbers.
3. Number, kind and resistance of relays in package.
4. Number, kind and arrangement of contacts on each relay.

20. *Acceptance.*

If, after physical inspection of the entire shipment and in accordance with the test, these specifications are met, the shipment will be accepted. If the specifications are not met, the shipment will be returned to the Manufacturer, who will pay all freight charges on the shipment.

SPECIFICATIONS FOR MECHANICAL AND ELECTRIC RELEASES.

1912.

1. *Assembly and construction.*

(a) Releases must be positive in action and free from mechanical defects in material and construction.

(b) Releases shall be set for .... (..) seconds and designed so that the interval can be varied to any time between fifteen (15) seconds and two (2) minutes by the Purchaser.

(c) Releases shall be provided with dust-proof covers arranged for locking or sealing.

(d) Releases shall be designed to prevent improper manipulation, change in adjustment or tampering without unlocking or breaking seal on cover.

(e) Each electric release shall, unless otherwise specified, be a separate unit under a separate cover, arranged for mounting on switchboard or wall.

(f) Contacts shall be self-cleaning and of non-corrosive materials. Each pair of contacts shall be a separate unit and so arranged as to be easily accessible.

(g) Binding posts, nuts and washers shall be in accordance with Railway Signal Association drawing 1070. Electrical connections shall be enclosed by cover.

(h) The relative position of electric releases shall be in accordance with Purchaser's drawing .... , dated ....

(i) $\left\{\begin{array}{l}\text{Electric}\\ \text{Electro-mechanical}\\ \text{Mechanical}\end{array}\right\}$ releases shall be designed for use on a .... type of machine in accordance with Purchaser's drawing ...., dated ....

(j) Releases shall be furnished $\left\{\begin{array}{l}\text{with}\\ \text{without}\end{array}\right\}$ contacts. There shall be .... normally closed and .... normally open contacts.

D. C. MOTOR—Specifications.

INDICATIONS, PRINCIPLES OF.

Signals.

Steel.
Machinery.
Specifications.

Switchboards.
Specifications.

SIGNALING PRACTICE.

1912.

Memorandum on the Essentials of Signaling,

Incorporated in the Report of the Committee on Transportation of the American Railway Association, May, 1911.

"The reports of various Committees of the Railway Signal Association and of the American Railway Engineering Association on the subject of signaling have been submitted to this Committee, with the request that the essentials of signaling be outlined or defined for the future guidance of their Committees.

The subject has been carefully analyzed and considered. There are three signals that are essential in operation and therefore fundamental, viz:

(1) Stop.
(2) Proceed with caution.
(3) Proceed.

The fundamental, "proceed with caution," may be used with the same aspect to govern any cautionary movement; for example, when:

(a) Next signal is "stop."
(b) Next signal is "proceed at low speed."
(c) Next signal is "proceed at medium speed."
(d) A train is in the block.
(e) There may be an obstruction ahead.

There are two additional indications which may be used where movements are to be made at a restricted speed, viz:

(4) Proceed at low speed.
(5) Proceed at medium speed.

Where automatic block system rules are in effect, a special mark of some distinctive character should be applied at the stop signal.

The Committee therefore recommends:

Signal Fundamentals.

(1) Stop.
(2) Proceed with caution.
(3) Proceed.

Supplementary Indications to be Used Where Required.

(4) Proceed at low speed.
(5) Proceed at medium speed.

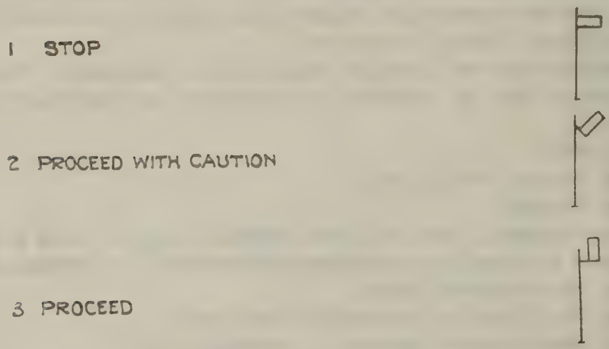
Stop signals operated under automatic block system rules should be designated by some distinctive mark to be determined by each road in accordance with local requirements."

Recommendations of Committee I.

Your Committee submits for approval the following two schemes of signaling in conformity with the recommendations of the Committee on Transportation.

Scheme No. 1.

Fundamentals.



As means of designating stop signals operated under automatic block system rules, the following are suggested:

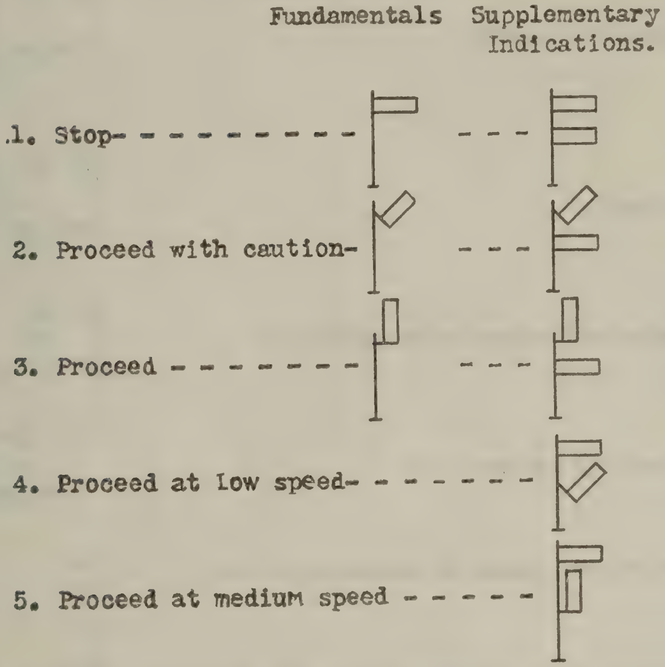
1. The use of a number plate; or

2. The use of a red marker light below and to the left of the active light; or

3. The use of a pointed blade, the blades of other signals giving the stop indication having square ends; or

4. A combination of these distinguishing features.

Scheme No. 2.


Fundamentals
Supplementary Indications.
1. Stop
2. Proceed with caution
3. Proceed
4. Proceed at low speed
5. Proceed at medium speed

As means of designating stop signals operated under automatic block system rules, the following are suggested:

1. The use of a number plate; or

2. The use of a red marker light below and to the left of the active light; or

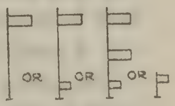
3. The use of a pointed blade, the blades of other signals giving the stop indication having square ends; or

4. A combination of these distinguishing features.

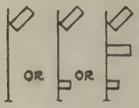
Having in view the practice of indicating diverging routes by several arms on the same mast, the Committee submits for approval the following to establish uniformity in this practice:

Scheme No. 3.

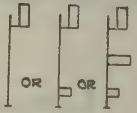
1 Stop..



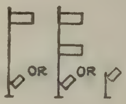
2. Proceed with caution ....



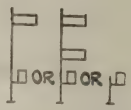
3. Proceed ....



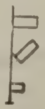
4. Proceed with caution on low-speed route ....



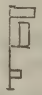
5. Proceed on low-speed route ....



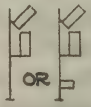
6. Proceed with caution on medium-speed route ....



7. Proceed on medium speed route ....



8. Reduce to medium speed ....



As means of designating stop signals operated under automatic block system rules, the following are suggested:

1. The use of a number plate; or

2. The use of a red marker light below and to the left of the active light; or

3. The use of a pointed blade, the blades of other signals giving the stop indication having square ends; or

4. A combination of these distinguishing features.

The above three schemes are submitted, after an earnest effort to carry out the Committee's instructions to submit a uniform scheme of signaling, with the idea that each scheme is complete in itself.

Transformers.

SINGLE-PHASE, LINE, OIL IMMERSED, SELF-COOLED, OUTDOOR TYPE, 4400 VOLTS OR LESS.

Trunking.
Wood.
Specifications.

SPECIFICATIONS FOR SINGLE-PHASE LINE TRANSFORMERS, OIL IMMERSED, SELF-COOLED, OUTDOOR TYPE, 4400 VOLTS, OR LESS.

1912.

1. *Purpose.*

The intent and purpose of these specifications is to describe materials to be furnished, work to be performed and method of construction for a complete transformer in every detail, in strict accordance with the plans and specifications hereto attached and such instructions as may from time to time be given by the Purchaser; and it is hereby understood that the Contractor agrees to furnish everything obviously necessary.

2. *Type.*

Transformers may be of the core or shell type. They shall be oil-immersed, self-cooled and designed for outdoor service.

3. *Frequency.*

Transformers shall be designed for operation on $\left\{\begin{matrix}25\\60\\..\end{matrix}\right\}$ cycles.

4. *Rating.*

Transformers shall be rated at the number of volt-amperes they can deliver without exceeding the specified rise of temperature when operating under normal conditions of frequency and voltages,

and shall have a rated capacity of $\left\{\begin{matrix}1000\\600\\400\\200\\....\end{matrix}\right\}$ volt-amperes.

5. *Primary.*

The primary voltage shall be $\left\{\begin{matrix}4400\\3300\\2200\\1100\\....\end{matrix}\right\}$ volts.

6. *Secondaries.*

(a) There shall be $\left\{\begin{matrix}1\\2\\3\\.\end{matrix}\right\}$ separate secondary windings as follows:

(b) $\left\{\begin{matrix}1\\2\\.\end{matrix}\right\}$ coils of $\left\{\begin{matrix}150\\100\\50\\\ldots\end{matrix}\right\}$ volt-ampere capacity. Each coil to have a minimum of $\left\{\begin{matrix}20\\15\\10\\5\\..\end{matrix}\right\}$ volts, open circuit. Each coil to have taps to give approximately twenty (20) and sixty (60) per cent. full voltage rating of the coil with proportionately reduced capacity.

(c) One (1) coil of $\left\{\begin{matrix}1000\\600\\400\\200\\\ldots.\end{matrix}\right\}$ volt-ampere capacity less the total volt-ampere capacity of the coils specified in Section 6 (b). This coil to have $\left\{\begin{matrix}1\\2\\3\\.\end{matrix}\right\}$ leads. Maximum voltage and volt-ampere load required between leads to be given and data submitted as per drawing VIII.

7. *Cases.*

(a) Transformer case shall be made of cast iron, provided with a cast iron cover. Eyebolts or lugs shall be provided for handling the transformer and lugs for supporting it. Case shall be free from leaks and shall be impervious to oil. Covers shall be provided with felt or other suitable gaskets. Plugs shall be provided at bottom of case for removing oil or water. When required, case shall be provided with a suitable terminal for grounding same.

7. *Cases.*—Continued.

(b) Each case shall bear a name plate on which is stated the name of maker, serial number, type and volt-ampere capacity; also the primary and maximum secondary voltages and frequency for which the transformer is designed.

(c) Transformer shall be fastened into the case so as to absolutely prevent the core and coils from shifting and yet permit them to be readily and quickly removed.

8. *Cut-outs.*

Two single pole fusible cut-outs shall be furnished with each transformer. These cut-outs shall be of a type suitable for use, at the rated voltage, in the high tension leads of the transformer to be protected, atmospheric conditions being considered. At least two (2) copper-tipped fuses of $\left\{\begin{matrix}3\\ .\end{matrix}\right\}$ amperes capacity shall be provided for use with each cut-out. Manufacturer shall submit details of cut-out construction for approval.

9. *Hangers.*

Transformer shall be provided with hanger irons for mounting same on poles.

10. *Leads and connection boards.*

(a) Each primary lead shall be brought out of the case directly from its coil through porcelain bushings, which shall be sealed into the case with a suitable compound, which will not soften sufficiently to flow at any temperature less than two hundred (200) degrees Fahr. (90° C.). The leads should be brought from the coil through the bushings in such a manner that the syphoning of oil by capillary attraction will be prevented.

(b) Leads from secondary coils shall be brought to a suitable terminal board with uniform arrangement and placed near the top of the transformer case so as to be easily accessible. Diagram of these leads to be fastened, in a suitable manner, to the inside of the cover for the case.

(c) Where the coil conductor is of small cross section, a flexible conductor shall be used from the coil to the connecting board or to the lead out of the case.

11. *Core.*

The core shall be built of laminated sheet steel, so firmly assembled that no buzzing is perceptible, and shall be non-aging.

12. *Oil.*

(a) The oil used in these transformers shall be a pure mineral oil obtained by the fractional distillation of petroleum, unmixed with any other substance. It shall be prepared and refined especially for the purpose and shall be free from moisture, acid, and alkali, and shall contain a minimum of sulphur compounds. The flash of the oil, determined in a closed cup, shall be not less than three hundred and thirty (330) degrees Fahr. (170° C.) and on cold test it shall not begin to solidify, and no wax shall form in the oil above thirty-two (32) degrees Fahr. (0° C.).

(b) Sufficient oil shall be furnished to completely immerse core and windings.

(c) The oil shall withstand a breakdown test of thirty thousand (30,000) volts between spherical surfaces of 0.5 cm radius, 0.40 cm apart.

13. *Performance.*

The Manufacturer, when required, shall submit performance data, (core loss, exciting current, copper loss, regulation at $\left\{\begin{array}{c}100\\90\\80\\70\\\cdots\end{array}\right\}$ per cent. power-factor, and volt-ampere efficiency) to be based upon methods as indicated in section 15, paragraphs (a), (b), (c) and (d) for each size of transformer.

14. *Inspection requirements.*

Transformers shall be tested at the place of manufacture, in the presence of a representative of the Purchaser, if the latter so desires. The Contractor shall give ten (10) days' notice to the Purchaser of his readiness to make the specified tests, and shall furnish all labor, materials, instruments, observers, complete facilities for tests, and such information regarding the transformers as is available without additional tests, as the Purchaser's representative may consider necessary for a definite opinion of their ac-

14. *Inspection requirements.*—Continued.

ceptability. He shall permit the representative to examine the transformers at all times from the beginning of their manufacture. In case the Purchaser should waive his right to factory inspection, he may require results of the tests in the form of a certified report.

15. *Description of tests.*

(a) Tests enumerated below shall be made upon all of the transformers.

(b) Core loss. Core loss and exciting current shall be taken cold at approximately seventy-seven (77) degrees Fahr. (25° C.). Core loss shall be measured with a wattmeter at normal frequency and voltage, using power from a generator giving a sine wave, when such is available. When a pure sine wave is not available, it shall be permissable to use any wave form which comes within the A.I.E.E. definition of a sine wave, adjusting the test voltage so that the core loss will be the same as with normal voltage and sine wave. Where voltage cannot be regulated by excitation of the generator, it must be done with autotransformers and not by rheostats in series with the transformer to be tested. The average of the core losses of the full number of transformers of the same size on one order shall not exceed the value stated in the proposal, and the maximum core loss must in no case exceed this value by more than ten (10) per cent.

(c) Exciting current. The average exciting current as observed during the test for core loss shall not exceed the value specified by the Manufacturer in his proposal and the maximum exciting current shall in no case exceed the stated value by more than $\begin{Bmatrix} 25 \\ .. \end{Bmatrix}$ per cent.

(d) Copper loss. The total copper loss shall be determined by separate measurements of primary and secondary resistances, at or corrected to seventy-seven (77) degrees Fahr. (25° C.). The average copper loss of the full number of transformers of the same size on the order shall not exceed the value of copper loss given for that size in the proposal, and the maximum copper loss must in no case exceed this value by more than ten (10) per cent.

15. *Description.*—Continued.

(e) Regulation. With the maximum rated load at the power-factors specified on all of the secondary circuits, the regulation of each of the secondary coils shall not exceed the values specified for that individual coil.

(f) In general the secondary coils referred to in Section 6 (b) can have poor regulation while the secondary coils referred to in Section 6 (c) should have the best regulation. Further data concerning the nature of load is given on drawing VIII.

(g) When calculated, the regulation for either the whole or part of the transformer shall be computed from the measured resistances and the reactance drop of voltage. using the following expressions.

For unity power-factor:

$$\text{Per cent. regulation} = \frac{100\ IR}{E} \quad (1)$$

For sixty (60) per cent. power-factor:

$$\text{Per cent. regulation} = 100 \left(\frac{0.6\ IR + 0.8\ P}{E} \right) \quad (2)$$

where E is the rated primary voltage, P the reactance drop of voltage, I the full load primary current (not including exciting current). The equivalent resistance, R, of primary and secondary combined, is found by multiplying the secondary resistance by the square of the ratio of turns, and adding to the primary resistance.

The impedance voltage, e, is found by short-circuiting the secondary windings, and measuring the voltage necessary to send full load current through the primary. The reactance drop is then computed from the expression

$$P = \sqrt{e^2 - I^2R^2} \qquad (3)$$

(h) Temperature. When tested for temperature rise, transformer may be overloaded and overexcited to hasten the rise of temperature to the ultimate value under normal load and the final temperature in any part, maintained for one hour under constant full load and normal voltage and frequency shall not exceed the temperature of the room (corrected to seventy-seven (77) degrees Fahr. (25° C.) by more than one hundred and twenty-two (122) degrees Fahr. (50° C.). The rise of temperature shall be determined by the increase of resistance of the windings and by thermometer in the oil, placed as directed by the repre-

15. *Description.*—Continued.

sentative of the Purchaser, and the highest indicated temperature shall be taken to determine the rise.

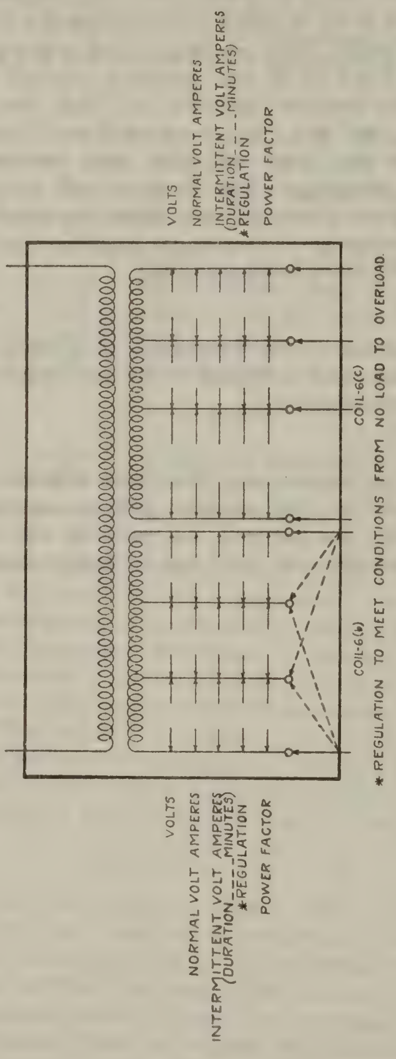
(i) Insulation. The windings shall withstand for one minute an e.m.f. of fifteen thousand (15,000) volts, sixty (60) cycles, between primary coil and core, case and secondary coil, and four thousand (4000) volts between secondaries and core and case, also between separate secondary windings. The primary coil shall withstand for one minute a test of three times the rated voltage, at suitable frequency. Transformer shall be filled with oil at the time the above tests are made.

16. *Aging test.*

At the option of the Purchaser, an artificial aging test may be made upon a sample of the core material, or upon a finished transformer.

17. *Acceptance.*

If, after an inspection of the entire shipment, the specifications are met, the material will be accepted. If the specifications are not met, the material will be returned and the Manufacturer shall pay all freight charges.


VOLTS
NORMAL VOLT AMPERES
INTERMITTENT VOLT AMPERES
(DURATION— — MINUTES)
*REGULATION
POWER FACTOR
COIL-6(c)
COIL-6(b)
VOLTS
NORMAL VOLT AMPERES
INTERMITTENT VOLT AMPERES
(DURATION—MINUTES)
*REGULATION
POWER FACTOR

* REGULATION TO MEET CONDITIONS FROM NO LOAD TO OVERLOAD.

SINGLE PHASE LINE TRANSFORMER
4400 VOLTS OR LESS

VIII

OCT. 1912

Voltage
Ranges for
Signal Work.

Voltage Ranges for Signal Work.

VOLTAGE RANGES FOR SIGNAL WORK.

1912.

(1st Range) Thirty (30) and less.

(2nd Range) Over thirty (30) to and including one hundred and seventy-five (175).

(3rd Range) Over one hundred and seventy-five (175) to and including two hundred and fifty (250).

(4th Range) Over two hundred and fifty (250) to and including six hundred and sixty (660).

(5th Range) Over six hundred and sixty (660).

**Wire.
Specifications.**

BONDING, COPPER-CLAD STEEL—Specifications.

BONDING, E. B. B.—Specifications.

LINE, COPPER-CLAD STEEL—Specifications.

LINE, W. P. D. B., B. B.—Specifications.

LINE, W. P. D. B., COPPER—Specifications.

RUBBER INSULATED, COPPER—Specifications.

STEEL, GALVANIZED, SIGNAL—Specifications.

**Wire
Inspection.**

REPORT, INSPECTION.

**Resistance
Table.**

TABLE, RUBBER INSULATION RESISTANCE.

WIRE INSULATING MACHINE.

Wires.
Copper-Clad
Steel Bond.
Specifications.

SPECIFICATIONS FOR COPPER-CLAD STEEL BONDING WIRES.

1912.

1. *General.*

The intent of these specifications is to provide for the furnishing of number 6 B. & S. gauge copper-clad steel bonding wires for bonding rail joints of steam railroads where electric track circuits are to be used.

2. *Conductor.*

The wire shall be composed of a steel core with a copper coat concentrically placed around and permanently welded thereto. The wire must be cylindrical in form and free from scales, flaws, inequalities, splits and all imperfections. The wires shall be cut and straightened to the length specified on order and be thoroughly annealed. The ends shall be sheared-cut and free from burrs.

3. *Properties.*

(a) The mechanical and electrical properties of the finished wire must be in accord with the following requirements:

B. & S. gauge.	Diameter in mils.	Per cent. elongation in 10 inches.	Conductivity per cent. of pure copper at 68° Fahr.
6	162	15	30 to 50

(b) The wire when broken by twisting, repeated bending, or when heated to a dull red and quenched in water at thirty-two (32) degrees Fahr. (0° C.), shall show no separation of the copper from the steel.

4. *Inspection and tests.*

(a) The Purchaser is to have the right to make such tests of the wire as he may desire.

(b) The Manufacturer must provide, at the mill, all apparatus and labor for making the required tests under the supervision of the Purchaser.

(c) Tests shall be made at the mill, on the wire before it is cut into lengths, or on samples submitted by the Manufacturer, and may also be made in the wire upon its arrival at destination.

(d) Tests shall, unless otherwise agreed upon between the Purchaser and Manufacturer, be made on one wire selected at random out of each lot of nine hundred (900) wires.

4. *Inspection and tests.*—Continued.

(e) Should the elongation be less than that specified, tests of two additional samples shall be made from the same lot, and they shall determine the acceptance or rejection of the wires.

(f) If, upon arrival at destination, the wires do not meet the requirements of these specifications, they will be rejected and returned to the Manufacturer, who shall pay all freight charges.

5. *Packing for shipment.*

The wires shall be put up in bundles of one hundred (100) or three hundred (300), as ordered, well burlapped at ends and securely fastened in not less than three (3) places.

6. *Tagging.*

A tag shall be securely fastened to each bundle, having plainly and indelibly marked thereon the number of and length of the wires, the Purchaser's order and inspection number and the proper shipping address.

SPECIFICATIONS FOR THIRTY PER CENT. CONDUCTIVITY HARD-DRAWN COPPER-CLAD STEEL LINE WIRE.

1912.

1. *General.*

The intent of these specifications is to provide for the furnishing of hard-drawn, bare, copper-clad steel line wire, having thirty (30) per cent. of the conductivity of that of pure copper.

2. *Conductor.*

The wire shall be composed of a steel core with a copper coat concentrically placed around and permanently welded thereto. The wire must be cylindrical in form, free from scales, flaws, inequalities, splits and all imperfections. Each coil must contain no weld, joint or splice.

3. *Properties.*

(a) The mechanical and electrical properties of the finished wire must be in accord with the following requirements:

B. & S. gauge.	Diameter in mils.	Minimum Breaking strength in pounds.	Weight per m. feet in pounds.	Maximum Resistance in ohms per mile at 89° Fahr.
6	162	1800	72.0	7.96
7	144	1450	58.0	10.08
8	128	1200	45.5	12.74
9	114	975	35.5	16.04
10	102	800	29.0	20.04
12	81	512	18.0	31.78

(b) The elastic limit shall be not less than fifty-five thousand (55,000) pounds per square inch. The elongation in ten (10) inches shall be not less than one (1) per cent.

(c) The wire when broken by twisting, repeated bending, or when heated to a dull red and quenched in water at thirty-two (32) degrees Fahr., shall show no separation of the copper from the steel.

4. *Inspection and tests.*

(a) The Purchaser is to have the right to make such tests of the wire as he may desire.

(b) The Manufacturer must provide at the mill all apparatus and labor for making the required tests under the supervision of the Purchaser.

(c) Should the breaking weight of the coil be less than that specified, tests of two (2) additional samples shall be made from the same coil and they shall determine the acceptance or rejection of the coil.

(d) Tests shall be made at the mill or on samples submitted by the Manufacturer, and may also be made on the wire upon its arrival at destination. The wire may be inspected before and after it has been covered.

(e) If, upon arrival at destination, the wire does not meet the requirements of these specifications, it will be rejected and returned to the Manufacturer, who shall pay all freight charges.

5. *Packing for shipment.*

(a) The wire shall be furnished in coils of not less than the following lengths:

1. Sizes 3 to 4, inclusive, one-fourth (1/4) mile.
2. Sizes 6 to 8, inclusive, one-third (1/3) mile.
3. Sizes 9 to 12, inclusive, one-half (1/2) mile.

(b) The diameter of the eye of the coil shall be not less than twenty (20) inches nor more than twenty-two (22) inches.

(c) Each coil shall be securely bound with an outside wrapping of burlap, with each turn of burlap overlapping the other one-half (1/2) its width.

(d) Each coil shall have the weight, length and size of wire, name of maker, the Purchaser's order and inspection number, and the proper shipping address plainly and indelibly marked on two (2) strong tags. One of these shall be attached to the coil inside the burlap and the other shall be attached to the coil outside the burlap.

SPECIFICATIONS FOR MINERAL MATTER, RUBBER COMPOUND INSULATED SIGNAL WIRE FOR 660 VOLTS OR LESS.

1912.

1. *Conductors.*

Conductors must be of soft-drawn, annealed copper wire having a conductivity of not less than ninety-eight (98) per cent. of that of pure copper, Matthiessen's standard. Each wire forming a conductor must be continuous without weld, splice or joint throughout its length, must be uniform in cross section, free from flaws, scales and other imperfections and provided with a heavy uniform coating of tin.

2. *Rubber insulation.*

(a) The rubber insulation shall be made exclusively from pure Upriver, fine dry Para rubber, of best quality, which has not previously been used in a rubber compound, solid waxy hydrocarbons, suitable mineral matter and sulphur, properly and thoroughly vulcanized. Before being mixed with the other ingredients the rubber shall be thoroughly washed and dried.

(b) Each of the dry mineral matter ingredients shall be thoroughly dried and passed through a sieve having not less than one hundred (100) meshes to the inch for the whiting and sixty (60) meshes to the inch for the other ingredients before they are mixed together.

(c) The ingredients used in the mixture shall be of a quality here specified and within the proportional limits by weight given in the following table:

Ingredient.	Percentage by weight.	
	Minimum.	Maximum.
Up-river, fine, dry Para rubber	30.5	32.
Whiting	....	30.
Zinc oxide	28.	As desired
Litharge	1.	12.
Sulphur	1.5	2.5
Ozokerite or paraffine	2.	3.

2. *Rubber insulation.*—Continued.

Ingredient.	Chemical composition.	Lowest grade acceptable.
Whiting	$CaCO_3$	96% pure
Zinc oxide	ZnO	Red seal

(d) The manufacturing processes shall be perfected to prevent, as far as practicable, excessive working of the rubber.

(e) The insulation must be homogeneous in character, tough, elastic, adhering to and be placed concentrically around the wires.

3. *Braiding.*

The rubber insulation must be protected with one (1) layer of closely woven cotton braiding at least one thirty-second (1/32) of an inch thick, saturated with a black insulating weatherproof compound that shall be neither injuriously affected by nor have injurious effect upon the braid at a temperature of two hundred (200) degrees Fahr.

4. *Acceptance.*

The product of those concerns only will be accepted who have satisfied the Purchaser that the requirements of these specifications will be complied with. The decision as to the quality of the wire furnished and the acceptance of the same shall be made by the Purchaser.

5. *Tests.*

(a) The Manufacturer shall provide, at his factory, apparatus and other facilities needed for making the required physical and electrical tests. The Manufacturer shall give free access to the place of manufacture and opportunity for inspecting and testing the product at all stages of manufacture to show that the required amount and quality of Para rubber and other ingredients are being used in the compound.

(b) Tests shall be made from samples taken from any part of any coil and may also be made upon the finished product immediately after being delivered. If the requirements of these specifications are not met the wire

5. *Tests.*—Continued.

will be rejected and the Manufacturer shall pay freight charges for return of such material.

(c) At the option of the Purchaser the wire, after being tested, shall not be shipped from the factory until an analysis of a sample has been made by a chemist chosen by the Purchaser, and the results of such analysis as interpreted by the Purchaser, shall be sufficient ground for rejection should the wire or insulation not conform to the requirements of these specifications.

6. *Physical test of copper conductors.*

Each solid conductor must stand an elongation of twenty-five (25) per cent. of its length in ten (10) inches before breaking and must be capable of being wrapped six (6) times about its diameter without showing signs of breakage.

7. *Conductivity test.*

The conductivity of the copper shall be determined by measuring the resistance of a length of the wire and comparing with Matthiessen's standard of copper resistance.

8. *Tinning test.*

(a) Samples of wire shall be thoroughly cleaned with alcohol and immersed in hydrochloric acid of a specific gravity of 1.088 for one (1) minute. They shall then be rinsed in clear water and immersed in a solution of sodium sulphide of a specific gravity of 1.142 for thirty-two (32) seconds and again washed. This operation shall be repeated three (3) times and if the sample does not become blackened after the fourth immersion, the tinning shall be regarded as satisfactory.

(b) The sodium sulphide solution must contain an excess of sulphur and should have sufficient strength to thoroughly blacken a piece of clean untinned copper wire in five (5) seconds.

9. *Braiding test.*

A six (6) inch sample of wire with carefully paraffined ends shall be submerged in fresh water of a temperature of seventy (70) degrees Fahr. for a period of twenty-

9. *Braiding test.*—Continued.

four (24) hours. The difference in weight of the sample before and after submersion must not be more than ten (10) per cent. of the weight of the sample before submersion less the weight of the copper and vulcanized rubber.

10. *Physical tests of rubber insulation.*

(a) A sample of the vulcanized rubber insulation not less than four (4) inches in length shall have marks placed upon it two (2) inches apart. The sample shall be stretched at the rate of three (3) inches per minute until the marks are six (6) inches apart and then at once released. One (1) minute after such release the marks shall not be over two and seven-sixteenths (2 7/16) inches apart. The sample shall then be stretched until the marks are nine (9) inches apart before breaking.

(b) The tensile strength of the rubber insulation as shown by tests made on a carefully prepared sample shall be not less than twelve hundred (1200) pounds per square inch. The sample, for five (5) minutes before and as near as practicable during the test shall be maintained at a temperature of seventy (70) degrees Fahr. The test to determine the tensile strength of the insulation shall be made upon as perfect a piece of vulcanized insulation as it is practicable to obtain from the wire being tested. The section of the test piece and the method of making the test shall be determined by the representative of the Purchaser, who shall, as far as it is consistent, conform to the practices and requests of the Manufacturer.

(c) The specific gravity of the rubber insulation shall be not less than 1.85.

11. *Chemical tests of rubber insulation.*

(a) The insulation shall show, on analysis, not less than thirty (30) nor more than thirty-three (33) per cent. of pure Upriver, fine, dry Para rubber, of best quality; not more than four (4) per cent. of waxy hydrocarbons, consisting of refined paraffine or pure ozokerite; not more than seven-tenths (0.7) of one per cent. of free sulphur; not more than two and five-tenths (2.5) per cent. total sulphur; freedom from all foreign matter and the mineral matter shall be such as will not have a deleterious effect on the insulation.

11. *Chemical tests.*—Continued.

(b) The rubber extractive in the vulcanized compound shall vary between the limits nine-tenths (0.9) and one and thirty-five one-hundredths (1.35) per cent. The vulcanized compound before being extracted with acetone shall be reduced in size sufficiently to pass through a twenty (20) mesh sieve.

12. *Electrical tests of rubber insulation.*

(a) The circular mills cross section, the thickness of the rubber insulation (measured at the thinnest point), the minimum insulation resistance in megohms per mile and the dielectric strength for the various sizes of wire shall conform to the following requirements:

Size B. & S. gauge.	Insulation wall.	Insulation resistance megohms per mile.	Test voltage alternating current.
0	4/32″	1300	8000
1	4/32″	1500	8000
2	4/32″	1600	8000
4	3/32″	1600	5000
6	3/32″	1800	5000
8	3/32″	2200	5000
9	5/64″	2000	4000
10	5/64″	2200	4000
12	5/64″	2500	4000
14	5/64″	2800	4000
16	2/32″	2800	3000
18	2/32″	2800	3000

(b) The coils of wire after being removed from the vulcanizer shall be kept for twenty-four (24) hours at the normal temperature of the factory storeroom before being placed in the testing bath.

(c) The test for insulation resistance must be made upon all wire after at least twelve (12) hours submersion in water and while still immersed results shall be corrected to a water temperature of sixty (60) degrees Fahr. Tests must be made with the wire in coils, suitable for examination and before the application of braid or other covering with a well insulated battery and galvanometer, with not less than one hundred (100) volts and readings must be taken after one (1) minute's electrification. The

12. *Electrical tests of rubber insulation.*—Continued.

test voltage must be applied to the completed length of wire before the insulation test for a period of five (5) minutes, using alternating current from a generator and transformer of ample capacity.

(d) The insulation resistance (megohms) at a given temperature shall be reduced to that at sixty (60) degrees Fahr. by dividing by the coefficient corresponding to that temperature. The tests shall be made at a temperature within the scope of this table.

Temperature degrees Fahr.	Coefficient shall be not greater than	Temperature degrees Fahr.	Coefficient shall be not less than
46	1.44	60	1.000
47	1.41	61	.974
48	1.37	62	.949
49	1.34	63	.925
50	1.30	64	.901
51	1.27	65	.878
52	1.24	66	.855
53	1.20	67	.833
54	1.17	68	.812
55	1.14	69	.791
56	1.11	70	.771
57	1.09	71	.751
58	1.06	72	.732
59	1.03	73	.713
60	1.00	74	.695
		75	.677

13. *Coils.* (a) The wire shall be furnished in coils of the length named for the following sizes of wire:

B. & S. gauge.	Length in feet.
14	2000
12	1500
10	1500
8	1500
6	1000

(b) Twenty (20) per cent. of the coils will be accepted if five hundred (500) feet long or over, or of any length where a coil, submitted for inspection and testing has been cut to secure a sample for testing.

(c) The inside diameter of a coil shall, unless otherwise specified, be not less than twenty (20) or more than twenty-two (22) inches.

14. *Packing for shipment.*

(a) The wire shall be shipped on reels or in coils as directed by the Purchaser.

(b) If shipped on reels they shall be amply strong and the wire shall be protected by lagging to prevent injury in transportation. A tag must be placed inside of the lagging and a stencil on the outside of each reel, giving the weight, the length of each piece of wire, the size of the wire, the name of the Manufacturer and Purchaser's order or inspection number plainly marked.

(c) If shipped in coils, each coil shall be securely bound with a layer of heavy wrapping paper and with an outside wrapping of burlap, with each turn of burlap overlapping the other one-half (1/2) its width.

(d) Each coil shall have the weight, length and size of wire, the name of Manufacturer and Purchaser's order or inspection number plainly and indelibly marked on two (2) strong tags. One (1) of these tags shall be attached to the coil inside the burlap and the other shall be attached to the coil outside the burlap.

TYPE OF WIRE INSULATING MACHINE AND PREFERENCE IN THE PLACING OF ORDERS.

1912

This Association with a view to future adoption as a part of the mineral matter rubber compound specification, recommends that the insulation be applied to the wire by the stripping machine process and that Manufacturers prepare to comply therewith.

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